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A Suggested Unit Course

MARINE ELECTRICAL CONSTRUCTION

(For Beginning Instruction)

Bulletin 345-U

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION
HARRISBURG
1943

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A Suggested Unit Course

MARINE ELECTRICAL CONSTRUCTION

(For Beginning Instruction)

Bulletin 345-U

Prepared by

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION
DIVISION OF INDUSTRIAL EDUCATION

In Cooperation With

SCHOOL DISTRICT OF PHILADELPHIA
SHIPBUILDING YARDS IN THE PHILADELPHIA AREA

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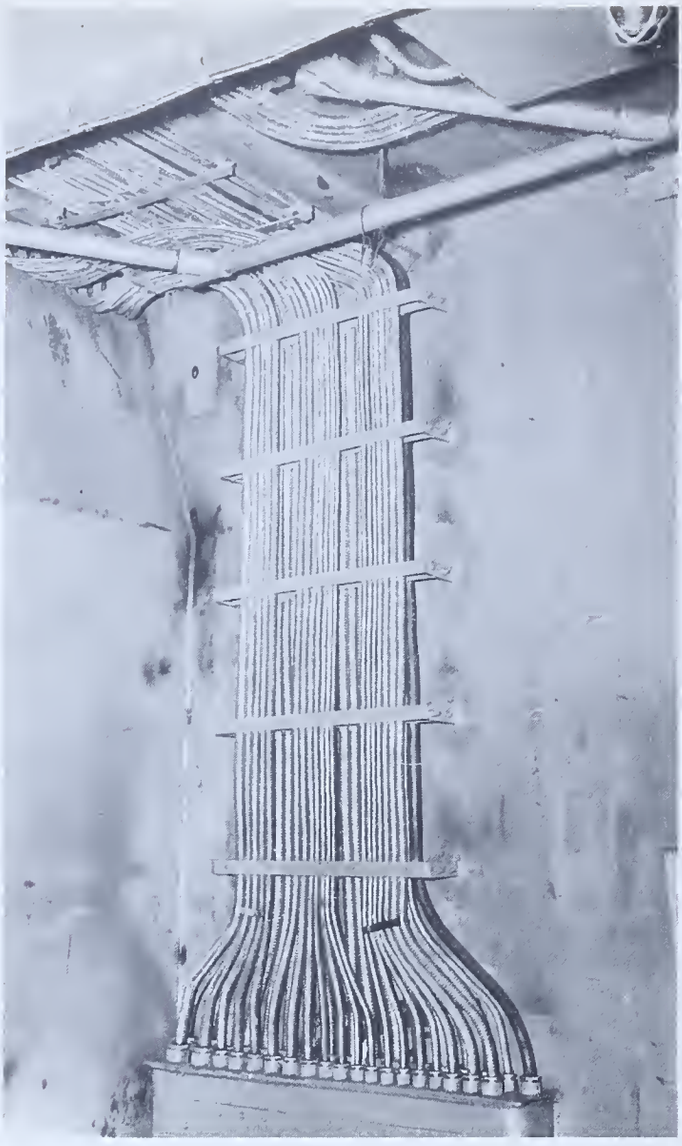
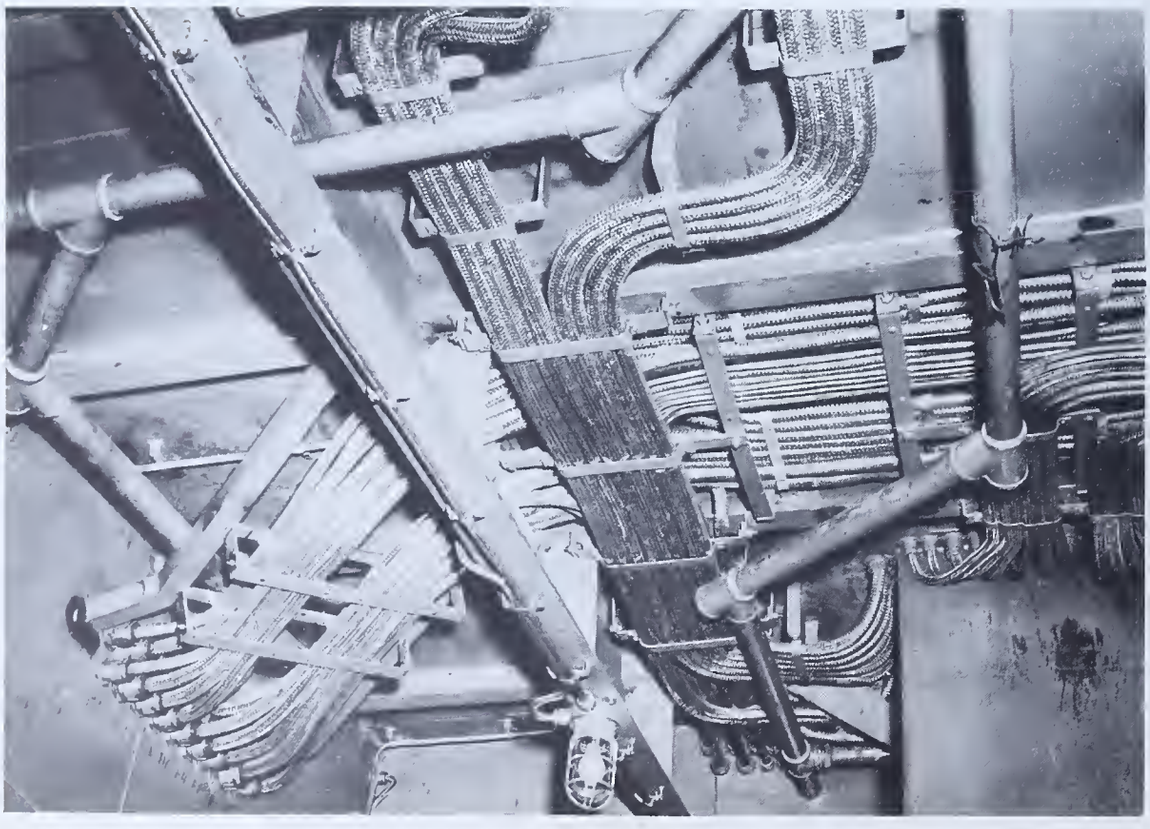
1943





Cable Runs

Foreword

This suggested unit outline is intended for training beginners in marine electrical construction practices. These units, which have been developed in close cooperation with marine electrical engineers, draftsmen, and mechanics, indicate the desirable content of a course which is intended to develop skill in fundamental processes and operations.

The unit course is based upon modern standards of practice for Navy electrical construction. Typical ship diagrams and field procedures comprising current Navy practices have been included. Although Navy practices are emphasized, procedures presented may readily be adapted to merchant construction.

Special acknowledgments are due to engineers, draftsmen, and mechanics who assisted in preparing wiring diagrams, illustrations, and descriptive matter for this bulletin. The following personnel of the Philadelphia Navy Yard assisted in preparation and review of this manual: Harry Price, Electrical Engineer; Harry Dalton, Planner and Estimator; William Heller, First Class Electrician; and Henry Schmidt, Thomas Scholl, Harry Campbell, and D. Rosenthal, electrical draftsmen. Mr. Price served as Technical Adviser and contributed greatly in the development of the text material.

Appreciation is extended to Mr. Charles F. Bauder, Director of Vocational Education, and to Mr. William E. Brunton, Assistant Director in charge of War Production Training, of the School District of Philadelphia, for cooperation in the development of the material.

This bulletin was prepared at the Philadelphia Field Curriculum Laboratory of the Pennsylvania Department of Public Instruction. Wayne W. Thompson, Adviser, Division of Industrial Education, supervised the preparation of materials at the Laboratory. The work was completed under the direction of Charles F. Zinn, Adviser, Division of Industrial Education, and under the general supervision of Paul L. Cressman, State Director of Vocational Training for War Production Workers.

FRANCIS B. HAAS

Superintendent of Public Instruction

June, 1943

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Instructors' Information

It is suggested that the early processes be given as exercises until the trainee is competent to do the jobs represented in the various drawings. The exercises can be accomplished either in the shop's "ship lay-out" or on panels apart from that area. Where various types of installation are called for, those conditions can be simulated in small panels or frames, or the materials called for may be simply clamped in a vise while the work is performed.

Unit 23 provides typical ship electrical drawings. The jobs represented in Drawings 3 to 7 are presented following the respective drawings, with a step by step procedure for each job on the drawing; these procedures involve the processes given in the earlier units.

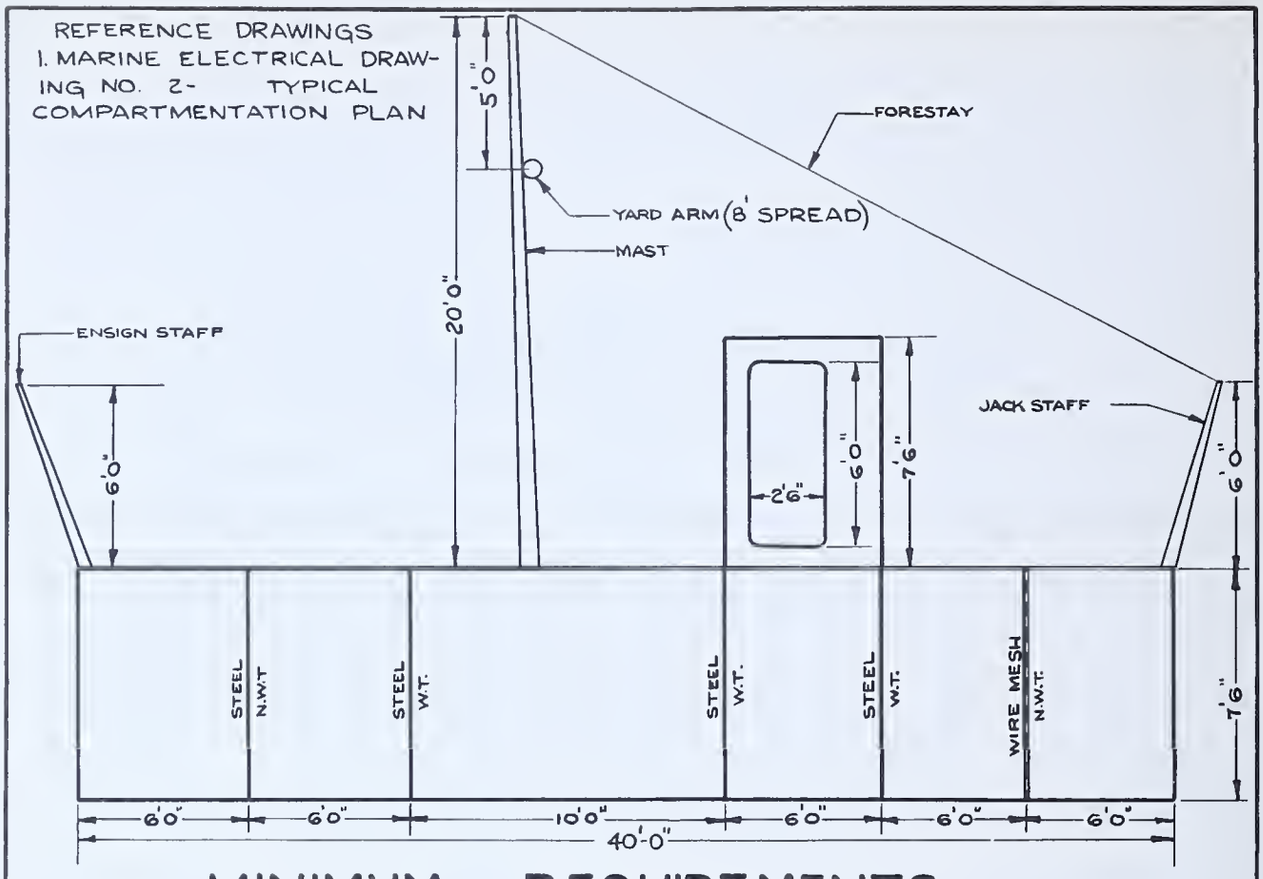
It is not intended that each trainee do every job, but he should manifest sufficient ability in each type of work before advancing.

The instructor should keep a progress chart of each trainee and carefully route the individual assignments in order to most efficiently utilize the time and materials at hand.

When the trainee is ready for further progress he may be assigned work from Drawings 8 and 9.

The installations shown on the composite drawing (No. 9) are the combined installations of the preceding drawings and involve advanced abilities in rack-work and electrical arrangement, offering experiences which represent completion of the "basic training" stage.

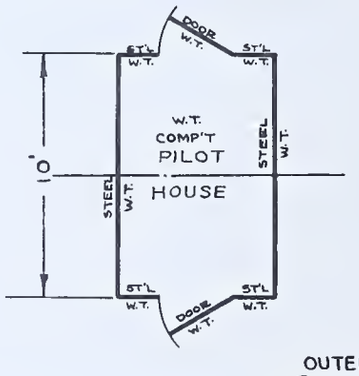
REFERENCE DRAWINGS
1. MARINE ELECTRICAL DRAWING NO. 2- TYPICAL COMPARTMENTATION PLAN



MINIMUM REQUIREMENTS FOR MARINE ELECTRICAL SHOP

MARINE ELECTRICAL DRAWING Nº 1

REFERENCE DRAWINGS:
1. MARINE ELECTRICAL DRAWING NO. 1 MINIMUM REQUIREMENTS FOR MARINE ELECTRICAL SHOP



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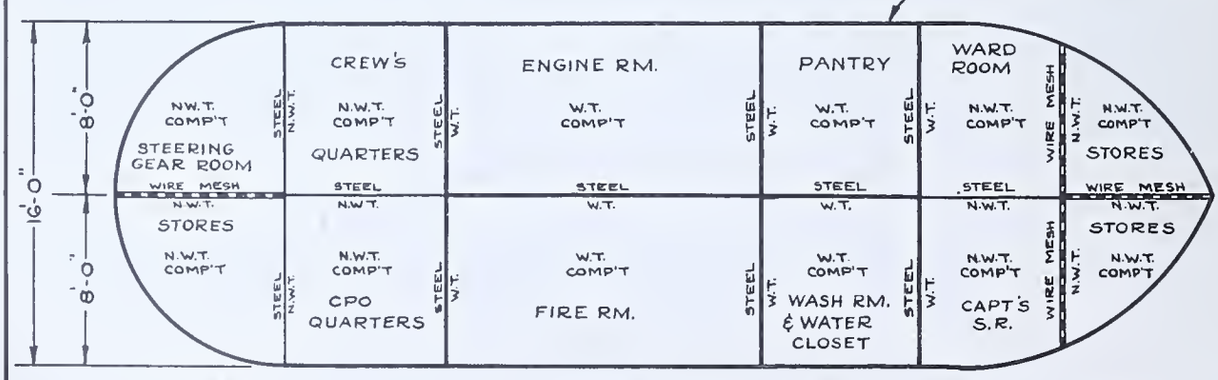
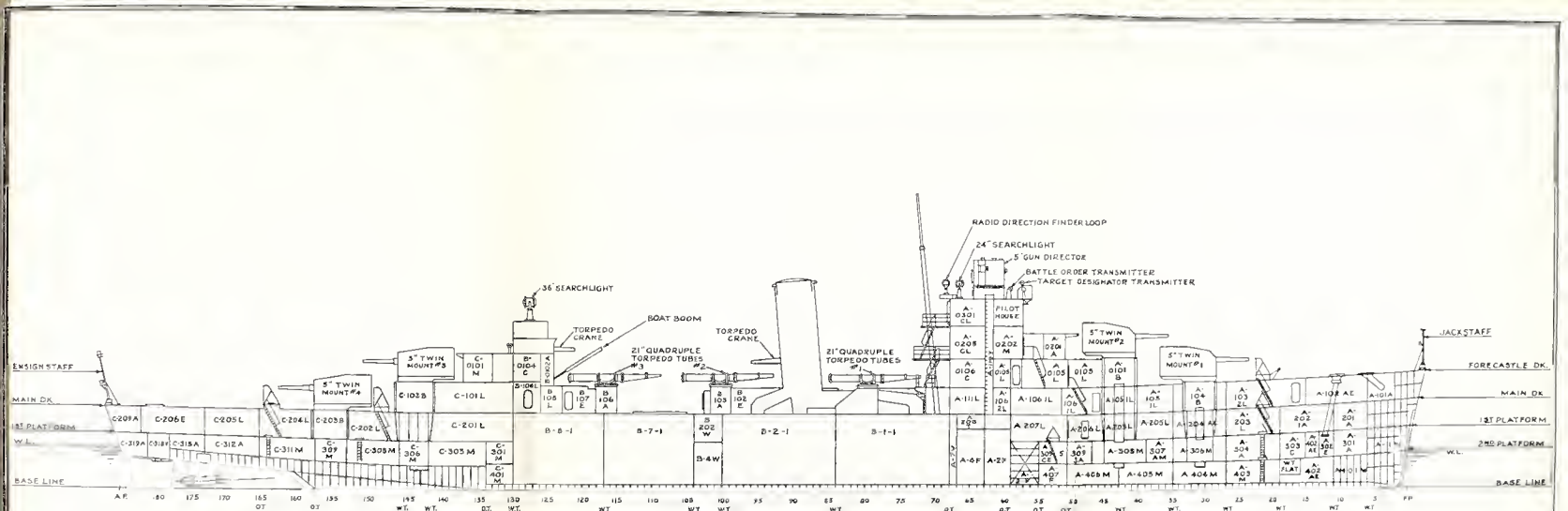


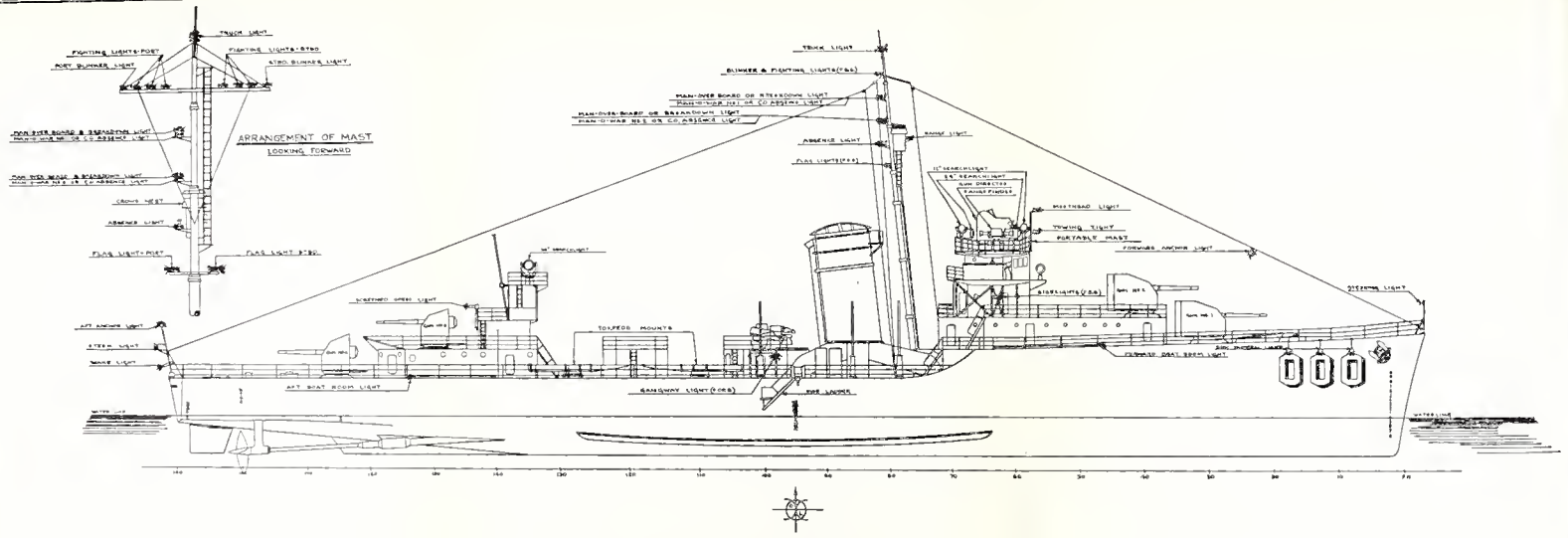
TYPICAL COMPARTMENTATION PLAN

MARINE ELECTRICAL DRAWING Nº 2



· TYPICAL U.S. DESTROYER ·

· INBOARD PROFILE ·



· TYPICAL U.S. DESTROYER ·

· OUTBOARD PROFILE ·

PART I

INTRODUCTORY INFORMATION AND PROBLEMS

UNIT 1 — NOMENCLATURE OF DECKS AND NUMBERING WATER-TIGHT COMPARTMENTS ON NAVAL VESSELS — Page 3

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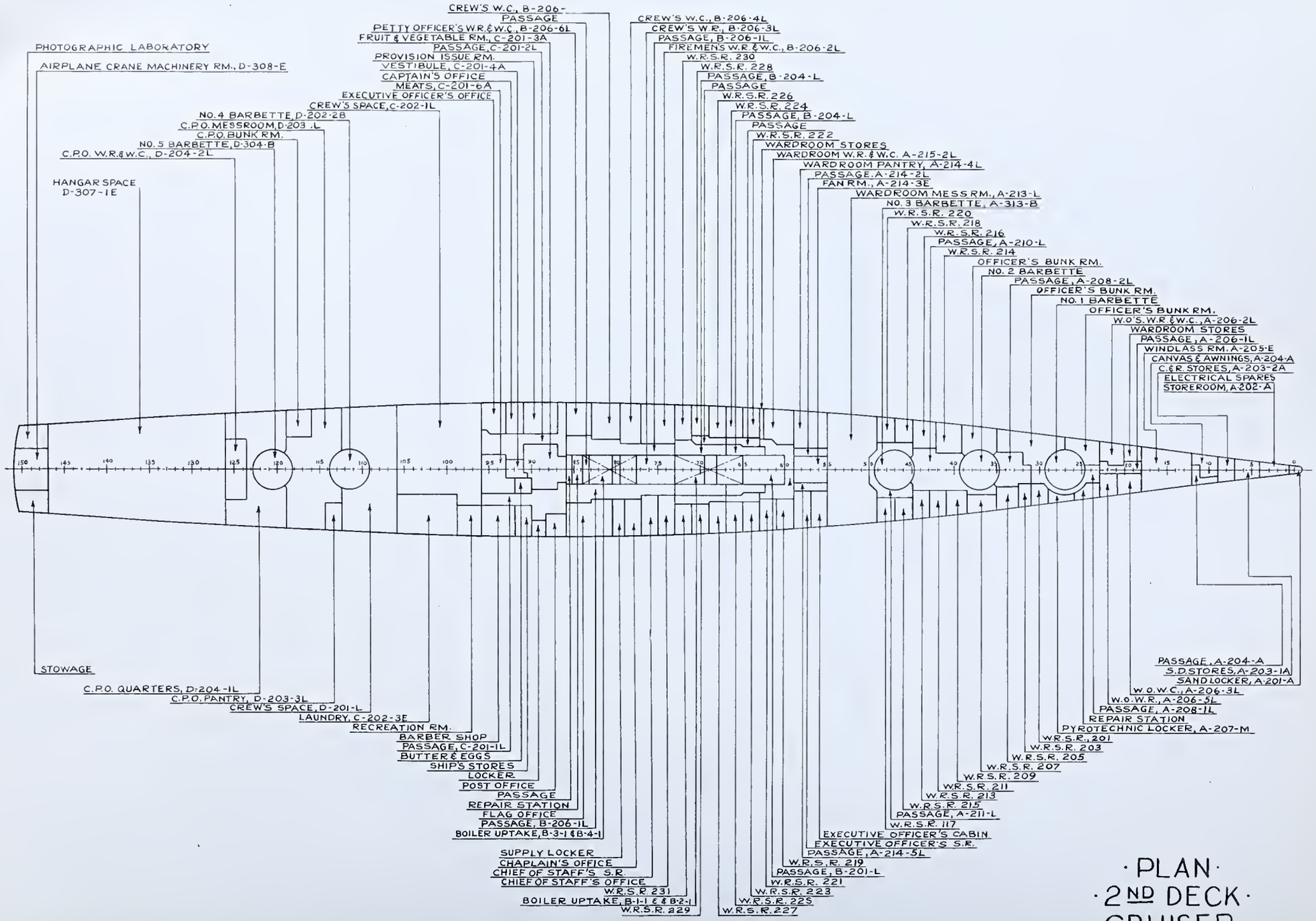
B. How to Add Fractions — Page 10

C. Method of Finding One-half of Fractions and Mixed Numbers — Page 12

D. Estimating Length of Cable on a Reel — Page 13



· PLAN ·
· 2ND DECK ·
· CRUISER ·

NOMENCLATURE OF DECKS AND NUMBERING WATERTIGHT COMPARTMENTS ON NAVAL VESSELS

(Excerpt from "Nomenclature of Naval Vessels" published by the U. S. Government Printing Office, Washington, D. C.)

There are two types of decks--complete decks and partial decks. A complete deck is a deck running the full length of the ship and a partial deck is a deck running only part of the length of the ship. Decks are named according to their location above or below the main deck.

A partial deck above the main deck at the bow is called the "forecastle deck"; at the stern, "poop deck"; amidships, "upper deck." The name "upper deck," instead of "forecastle deck" or "poop deck," is applied to a partial deck extending from the amidships to either bow or stern. A partial deck above the main, upper, forecastle, or poop deck and not extending to the side of the ship is called the "superstructure deck."

A complete deck below the main deck is called the "second deck." Where there are two or more complete decks below the main deck, they are called the "second deck," "third deck," "fourth deck," etc. A partial deck above the lowest complete deck and below the main deck is called the "half deck." A partial deck below the lowest complete deck is called a "platform". Where there are two or more partial decks below the lowest complete deck, the one immediately below the lowest complete deck is called the "first platform," the next is called the "second platform," and so on.

Decks which for protective purposes are fitted with plating of extra strength and thickness shall be further defined, for technical purposes, as "protective" and "splinter," in addition to their regular names. Where there is only one such deck, it is defined as "protective" and where there are two, that having the thicker plating is defined as "splinter" in addition to the regular names.

Watertight compartments are specified by letters and numbers. Compartments in each division are numbered beginning at the forward end of each division. The ship is considered as divided into three principal divisions, lettered A, B, or C, from forward aft.

Division A -- This comprises all of the space between the stem and the forward transverse bulkhead of the forward machinery compartment.

Division B -- This comprises all of the space between the forward transverse bulkhead of the forward machinery compartment and the after transverse bulkhead of the after machinery compartment.

Division C -- This comprises all of the space aft of the after transverse bulkhead of the after machinery compartment.

The term "machinery compartment" is construed as meaning fire rooms, boiler rooms, engine rooms, main motor rooms, main machinery spaces, and compartments in which auxiliaries of the main propelling machinery are located. These divisions are considered as extending from the keel to the highest deck in the line of the bulkheads, or the bulkheads prolonged.

In case the bulkheads do not extend to the highest deck, any space between decks that extends through two of the principal divisions is numbered as if it were situated entirely in the forward division of the two in which it is placed, and has this number only. Main compartments with permanent openings to the top side, such as boiler rooms, are considered as completely bounded by tight structure for numbering purposes.

All numbers in each division begin at the forward end of that division. Compartments on the starboard side of the ship have odd numbers; those on the port side, even numbers. All compartments and spaces that are completely bounded by watertight, oiltight, airtight, or fumetight structure are numbered. Where a watertight compartment located below the weather deck is divided into two or more airtight or fumetight spaces by airtight or fumetight bulkheads, the appropriate number is assigned the watertight compartment and each airtight or fumetight subdivision within the compartment is designated by the addition of a suffix to this number. Thus, if watertight compartment A-312L contains a fumetight or airtight longitudinal bulkhead, the space to starboard of this bulkhead is designated as A-312-1L and the space to port as A-312-2L.

Oiltight and watertight compartments in each division on the main deck are numbered from 101 to 199, and those on each successive deck or platform below the main deck are numbered in the next higher hundred series; namely, those on the second deck are numbered from 201 to 299; on the third deck, from 301 to 399, etc. Watertight compartments on the next deck or platform above the main deck are numbered 0101 to 0199, and those on each successive deck or platform above the main deck are numbered in the next higher hundred series, prefixed with a zero. For example, a ship that has a superstructure, forecastle, main, second, and third deck, and a first and second platform, the oiltight and watertight compartments are numbered as follows:

On superstructure deck	0201 to 0299
On forecastle deck	0101 to 0199
On main deck	101 to 199
On second deck	201 to 299
On third deck	301 to 399
On first platform	401 to 499
On second platform	501 to 599
In hold, if there are no more platforms	601 to 699

Upper inner bottom compartments are numbered from 801 to 899 and lower inner bottom compartments are numbered 901 to 999. It will be noted that the prefix zero of a compartment number indicates that the compartment is above the main deck. If there is not a third deck the compartments on the first and second platforms and in the hold are numbered 301 to 399, 401 to 499, and 501 to 599, respectively. If there is a fourth deck, the compartments on the fourth deck and first and second platforms and hold are 401 to 499, 501 to 599, 601 to 699, and 701 to 799, respectively.

On modern destroyers the compartment numbers in each division are as follows:

On main deck	101 to 199
On first platform	201 to 299
On second platform	301 to 399
In hold	401 to 499

Compartments in each division with no decks, extending from inner bottom or outside plating through two or more deck spaces, such as those in protective layers, engine rooms, boiler rooms, deep peak tanks, fuel-oil tanks on certain battleships, cargo holds, etc., are numbered from 1 up to 100. Boiler and engine rooms are given the lowest numbers, B-1, B-2, B-3, etc. Where there is a half deck owing to the sheer or other cause, or where there is a flat between regular decks, such as cofferdam flat over oil tank, no change in the hundred series is made on account thereof. The above scheme of numbering is intended to give an indication of the vertical location of the compartments which, in connection with the divisional fore and aft location, will give a very fair idea of the position of the compartments.

The number of a compartment is always prefixed with the letter indicating the general division of the ship in which it is placed and separated from the number by a hyphen, as A-21, B-3, etc.

To define further the contents or main use of a compartment, the compartment number is followed by a designating letter, as follows:

A for storerooms.
B for gun and torpedo battery compartments.
C for ship control and fire control.
E for machinery compartments.
F for fuel compartments.
LUB for lubricating oil storage tanks.
GAS for gasoline compartments.
L for living compartments.
M for ammunition spaces.
V for void compartments.
W for water compartments.

A double-bottom compartment used for feed water is designated B-910 W, for oil B-909 F, if void A-902 V. When a space is devoted to several main purposes, two or more designating letters are used. Thus a living compartment containing secondary battery guns is designated B-115 B L.

Nomenclature of Machinery Spaces

Fire room - A compartment containing boilers and the station for "firing" or operating same.

Boiler room - A compartment containing boilers but not containing station for "firing" or operating the boilers.

Boiler operating station - A station from which a boiler or boilers are operated.

Boiler central control station -- A station for directing control of all boilers at boiler operating stations.

Boiler emergency station -- A station for a chief water tender from which he may proceed with minimum delay to any fireroom, boiler operating station, or boiler room from which trouble has been reported.

Engine room -- A compartment in which main propelling unit or units are installed.

Engine operating station — A location or compartment from which a main propelling unit or units are operated.

Machinery spaces — A collective term designating all the major compartments in which machinery is located.

Numbering Compartments

The number of compartments is shown by means of label plates and tags of two types—engraved and embossed. Doors, hatches, and manholes are also numbered by means of label plates and tags. The inscription on door, hatch, or manhole plates is combined with that of the compartment or several compartments to which they provide access. Label plates are placed in a conspicuous location where they may be readily seen.

The following is an example of an inscription taken from the label plate on a door:

4-16-2
C.P.O. Stores
A-412

The first line of the inscription is the number of the door, the second the designation of the compartment, and the third, the compartment number to which the door gives access.

From the above it will be noted that the door, hatch, or manhole number consists of two or three parts, separated by hyphens. The first part corresponds to the deck number; the next part, the frame number just forward of the hinge of the door; and the last part, the number of the door, if there is more than one door on the same frame on the deck designated by the first part; if not, the third part may be omitted. For the first part of their numbers, hatches and manholes take the number of the deck through which they are cut. Odd numbers are used in the third part for doors located on the starboard side and even numbers on the port side. For example:

Door 3-24-1 is on the third deck, frame 24, or between frames 24 and 25, starboard side.

Door 3-24-2 is on the third deck, frame 24, or between frames 24 and 25, port side.

Hatch 3-24-2 is on the third deck at or immediately aft of frame 24 on the port side.

In the principal living compartments and elsewhere throughout the length of a ship as may be necessary to locate readily a particular place, every fifth frame is numbered. The numbers may be seen on the beams in a conspicuous place along passageways and other routes of travel and are located as near the bottom edge of a beam as practicable.

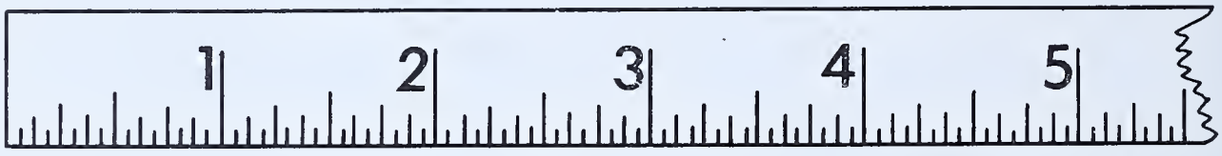
Abbreviations allowable when inscriptions are long are as follows:

Amm.	for ammunition.	Mag.	for magazines.
A.T.	for airtight.	M. H.	for manhole.
Aux.	for auxiliary.	Med.	for medical.
B.H.	for bulkhead.	M. T.	for flametight.
C. & R.	for construction and repair.	Nav.	for navigation.
		N.T.	for nontight.
Circ.	for circulating.	Offs.	for officers.
Compt.	for compartment.	Ord.	for ordnance.
Const.	for construction.	O.T.	for oiltight.
C.P.O.	for chief petty officers.	R.S. Mag.	for ready-service magazine.
Cu. Ft.	for cubic feet.		
Dis.	for discharge.	S.D.	for supply department.
E.	for engineering.	Stbd.	for starboard.
Elec.	for electric.	Suc.	for suction.
Equip.	for equipment.	T.	for tons.
Evap.	for evaporator.	Torp.	for torpedo.
For'd.	for forward.	Trans.	for transverse.
F.O.	for fuel oil.	Vent.	for ventilation.
Fr.	for frame.	V.T.	for voice tube.
F.T.	for fumetight.	W.	for weathertight.
Ft.	for feet or foot.	W.C.	for water closet.
F.W.	for fresh water.	W.L.	for waterline.
Gals.	for gallons.	W.O.	for warrant officers.
In.	for inch.	W.R.	for wardroom.
J.O.	for junior officers.	W.T.	for watertight.
Lub.	for lubricating oil.		

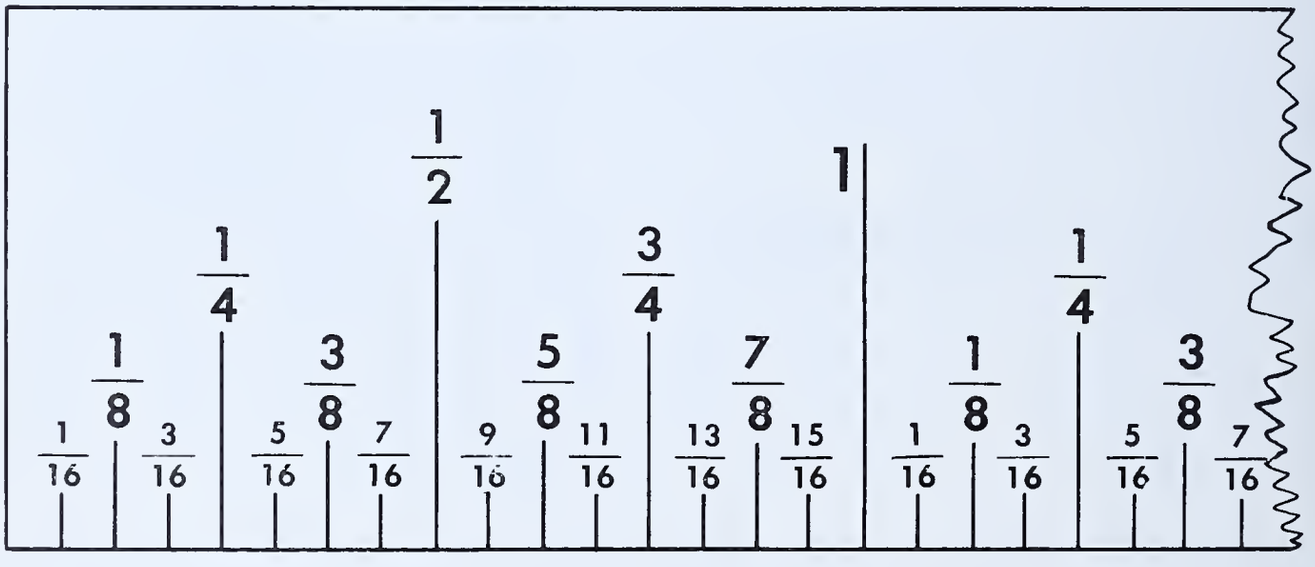
READING THE SIX-FOOT FOLDING RULE

The standard unit of distance for this country is the foot. The understanding of its division into inches and their parts, is essential to all workers in the trades.

It is so elementary a knowledge that most mechanics neglect its presentation to the new apprentice. This may not be justified; hence this unit and test are submitted to check rule-reading ability.



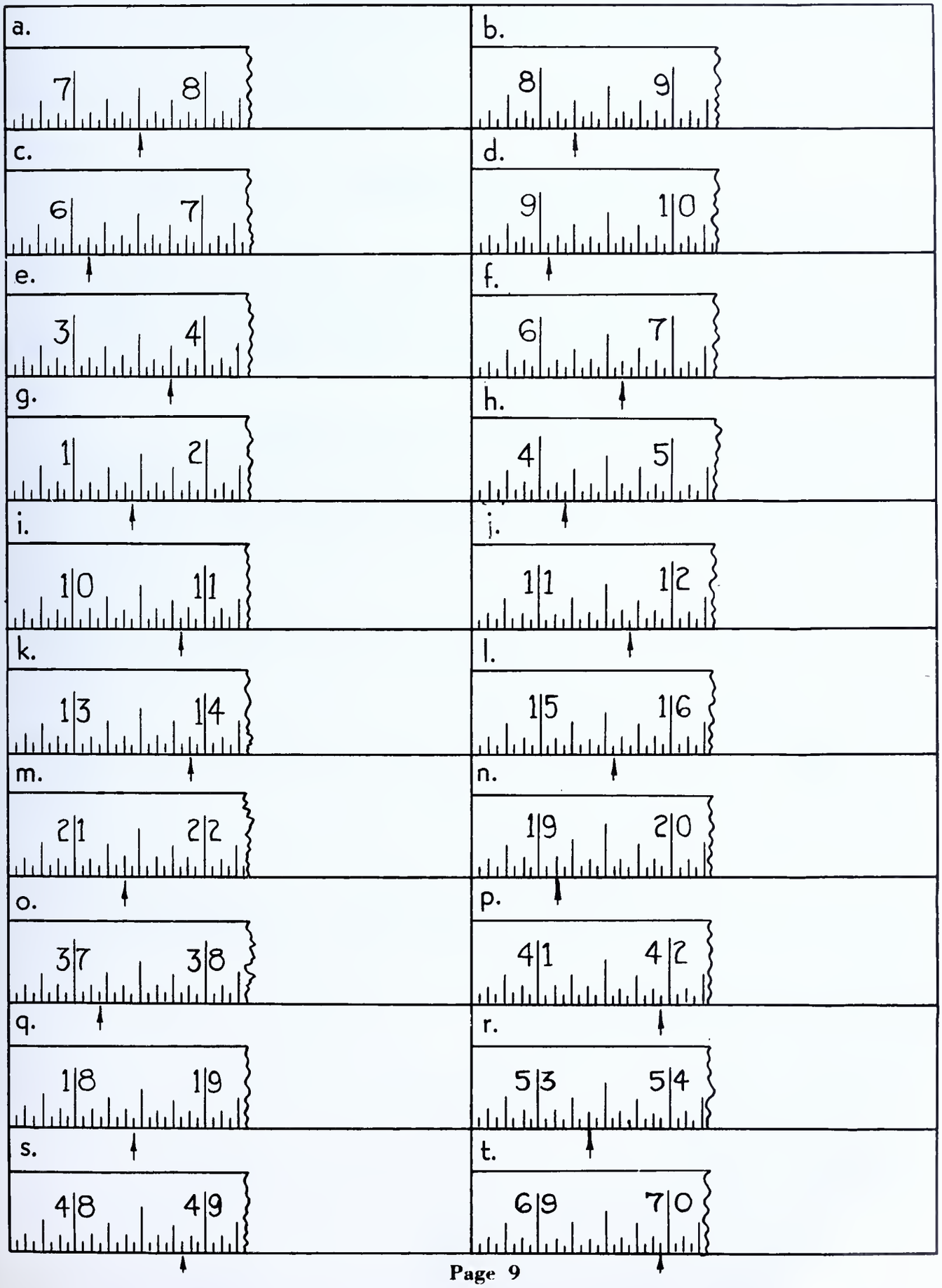
Note on the enlarged inch the fractional designations of the divisions of the inch on the ordinary six-foot rule.



The proper designation of these divisions must be memorized. The fractional parts are always expressed in their lowest terms. The midpoint of the inch is called one-half inch, although it is also the second quarter, the fourth eighth, and the eighth sixteenth; reduced to lowest terms it is one-half inch. Learn the correct sequence of these parts and refer to them always as shown in the enlarged inch. The symbol for the inch is the mark ", thus $\frac{1}{2}$", $\frac{1}{4}$", 1-1/8", etc. The symbol for the foot is the mark ', thus 1', 6', 19' etc. To express distance the feet and inches are written thus: 6' 1", 7' 11$\frac{1}{2}$", or 9' 0$\frac{1}{4}$".

EXERCISE FOR READING A RULE

On a separate sheet of paper, print in, opposite each letter, the distance represented. Express as inches and their fraction; where the distance is over twelve inches, write as feet, inches, and their fraction.



HOW TO ADD FRACTIONS

Most trainees in the field have had instruction in fractions and a "refresher" course should be all that is required to bring back that ability.

Fractions should be considered as portions of a whole, and their addition as putting those portions together, rather than abstract calculations.

The part of the fraction above the line is the numerator, below the line the denominator; e.g., in the fraction $\frac{1}{2}$, one is the numerator and two is the denominator.

The Steps In Adding Fractions

1. Calculate lowest common denominator

   In order to add fractions, the denominators must be made the same number. To add 1/2 + 1/8 we must establish a denominator which is "common" to all the fractions involved. This is the lowest number into which every one of the denominators can be divided evenly. Thus 8 will be the lowest common denominator here. Do Exercise 1.

2. Change all fractions to the lowest common denominator

   To change the denominator of 1/2 to 8 multiply the entire fraction by 4 (the number of times 8 contains 2); 1/2 then becomes 4/8. This is the same fraction but differently expressed. Do Exercise 2.

3. Add the numerators

   Once the denominators are the same the fractions can be added. 4/8 + 1/8 = 5/8. Only the numerators are added. Do Exercise 3.

4. Reduce the addition to lowest terms

   If the total is more than one, those units are written as a whole number and the remainder as a fraction. Thus 2/8 + 4/8 + 3/8 = 9/8. Since 8/8 is 1, write 9/8 as 1-1/8. Do Exercise 4.

5. Add any whole numbers to this result

   To add mixed numbers, i.e. a whole number which is accompanied by a fraction, thus 1-1/2 + 4-1/4, the whole numbers are added separately and included in the answer, 1-1/2 + 4-1/4 = 5-3/4. Do Exercise 5.

Summary of the steps in adding fractions

1. Calculate lowest common denominator.
2. Change all fractions to this denominator.
3. Add the numerators.
4. Reduce the addition to lowest terms.
5. Add any whole numbers to this result.

Exercise 1.

What would be the lowest common denominator to include:

1/2 and 1/4, 1/2 + 1/4 + 1/8, 1/2 + 1/4 + 1/8 + 1/16, 1/16 + 3/16,

1/2 + 1/4 + 1/32.

Exercise 2.

Change these fractions to the following denominators:

1/8 = ?/16, 1/2 = /8, 1/4 = /16, 1/2 = /4, 1/4 = /8,

1/2 = /16, 3/4 = /16, 7/8 = /16, 13/16 = /32, 3/4 = /8,

3/8 = /32, 5/8 = /16, 3/4 = /32, 15/16 = /32.

Exercise 3.

Add:

4/8 + 1/8 = , 6/8 + 1/8 = , 1/4 + 1/4 = , 3/8 + 4/8 = ,

7/16 + 3/16 = , 3/32 + 27/32 =

Exercise 4.

Reduce to lowest terms:

10/16, 8/8, 4/8, 2/8, 4/16, 26/32, 16/16, 13/8, 30/16,

22/4, 40/32, 41/32

Exercise 5.

Add and reduce to lowest terms:

1-1/2 + 2-1/2, 1-1/4 + 1-3/4, 1-1/8 + 2-3/8, 3-3/16 + 4-3/16,

5-1/2 + 1-7/8 + 9-3/16, 27-3/32 + 15-3/16, 27-1/16 + 9/16,

29-3/16 + 21/32, 13-13/13 + 11-11/16.

METHOD OF FINDING ONE-HALF OF FRACTIONS AND MIXED NUMBERS

One-half of any fraction is obtained by doubling the denominator of the fraction. 1/2 of 1/8 = 1/16, 1/2 of 1/4 = 1/8, 1/2 of 1/2 = 1/4, 1/2 of 3/16 = 3/32, 1/2 of 3/32 = 3/64, etc.

One-half of mixed numbers:

If whole number is even: Thus 1/2 of 18-7/8

1. Obtain mentally 1/2 of the whole number (1/2 of 18 = 9)
2. Find 1/2 of the fraction by doubling its denominator (1/2 of 7/8 = 7/16)
3. Combine results (1/2 of 18-7/8 = 9-7/16)

If whole number is uneven: Thus 1/2 of 7-7/8

1. Take 1/2 of next lower even number (1/2 of 6 = 3)
2. Add numerator and denominator of the fraction (7 + 8 = 15)
3. Use this as numerator of a new fraction
4. Double denominator of original fraction (2 x 8 = 16)
5. Use this as denominator of the new fraction (15/16)
6. Combine results of these steps (1/2 of 7-7/8 = 3-15/16)

Practice with various mixed numbers, and check either by addition or doubling of the result to secure original figure.

Adding thus: 3-15/16 + 3-15/16 = 6-30/16 or 7-14/16 = 7-7/8

or doubling thus: 2 x 3-15/16 = 7-7/8

Problem: Find one-half of the following:

1/4, 1/16, 3/8, 3/4, 7/16, 2-1/2, 4-1/4, 8-7/8, 10-15/16, 3-1/2, 5-1/4, 7-5/8, 7-5/16, 9-15/16, 11-9/16, 11-11/16, 12-3/4, 15-1/16, 19-3/8, 21-13/16

ESTIMATING LENGTH OF CABLE ON A REEL

In some yards a stock clerk issues cable in the requested lengths, and records on a tag the amount left on the reel. Other yards deliver reels to a ship and the required amount is taken and no record made as to either the amount taken or left on the reel. The following is a method of calculating the amount of cable on a reel. The knowledge of such length will enable the worker to know whether sufficient cable for his job is on a particular reel without actually unreeling, measuring, and rewinding.

1. Secure the following information

a. Cable size (O.D.), Fig. 1.	Assume 3/4"	= .75"
b. Outside diameter of reel core (D1)	"	6"
c. Outside diameter of last turn of cable (D2)	"	22"
d. Inside width of reel.	"	20"

2. Find thickness of cable on reel

Outside diameter of last full layer of cable (D2 above) MINUS outside diameter of core. Divide result by 2.

$$\frac{D2 - D1}{2} = \text{Thickness of cable on reel (Th)}$$

$$\frac{22" - 6"}{2} = 8"$$

3. Find the average diameter

Average diameter equals the sum of core D1 and the thickness of cable on reel.

D1 + Th. = Average Diameter
6 + 8 = 14"

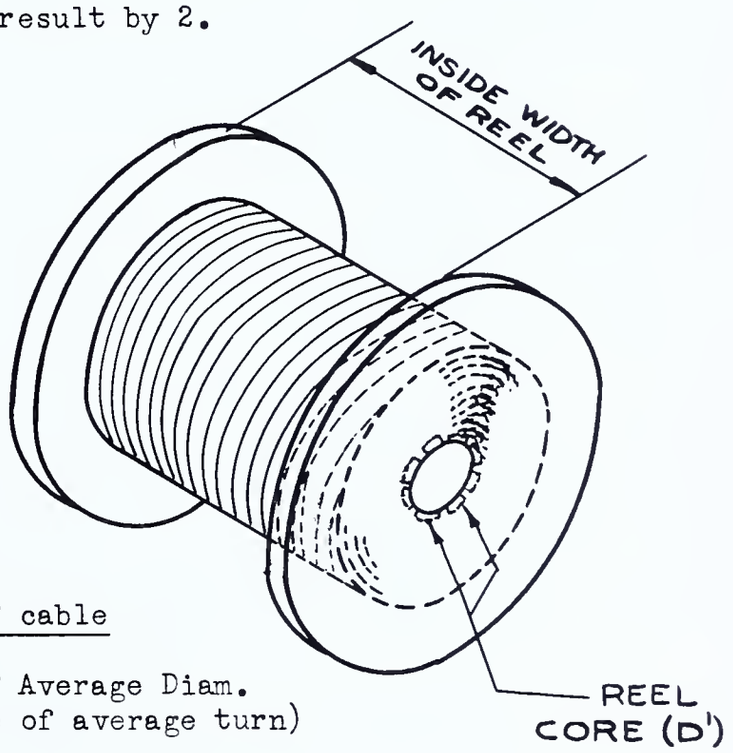


FIG. 1

4. Find the average length of one turn of cable

Ave. Diam. x π = Circumference of Average Diam. (length of cable of average turn)

π = 3.1416

$$14" \times 3.1416 = 43.98" \text{ or } \frac{43.98}{12} \text{ ft} = 3.665 \text{ ft.}$$

5. Find the number of rows across reel

a. Count rows if reel is open
b. If concealed

$$\frac{\text{Inside width of reel}}{\text{Cable size}} = \text{Number of rows (carry to one decimal place)}$$

$$\frac{20"}{.75"} = 26.0 \text{ rows}$$

6. Find the number of layers

$$\frac{\text{Th.}}{\text{Cable Size}} = \text{Number of layers (use next larger whole number)}$$

$$\frac{8"}{.75"} = 10.66 \text{ (use 11.00) layers}$$

7. Length of Cable = Average Length x Rows x Layers

3.66 ft x 26 x 11 = 1,046.76 ft. = length of cable on reel

8. If the last layer is not complete, and it was not counted as a layer in Step 6, now calculate its length. Circumference = π x Diam. (Change inches to feet in result.) Then multiply by number of rows it has. Add this to the result of Step 7. (Note: if the incomplete layer has been included, the length of missing cable should be subtracted. Number of turns (rows) gone x circumference of that layer.)

Practice Problems:

	A	B	C	D
Cable	1/2"	5/8"	7/8"	1-1/16"
Reel Core	16"	18"	20"	24"
Diam. last full turn cable	36"	38"	40"	46"
Inside Reel	20"	22"	24"	24"

9. A hasty but less accurate method is as follows:

a. Estimate the diameter of the middle layer in feet and decimal fractions of a foot.

Note: This point of measurement is the mid-point of the diameter of the middle layer if there is an odd number of layers; otherwise, it is the diameter between the middle layers.

b. Multiply this diameter by 22/7 (the rough fraction for pi). The result is the circumference of one average layer.

c. Multiply result by number of turns on the layer, to secure length of cable per layer.

d. Multiply by number of layers to secure length of cable on reel.

PART II

CABLES

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UNIT 4 — SIZES OF MARINE ELECTRIC CABLES Page 23

UNIT 5 — COLOR CODE FOR MULTIPLE CONDUCTOR CABLES AND TELEPHONE CABLES Page 25

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CLASSES, TYPES, AND USES OF MARINE ELECTRIC CABLES

The physical, chemical and electrical conditions encountered in the varied electrical systems of the marine field, particularly in naval construction, necessitate the selection of special classes and types of electric cables.

The cable must be selected with the following considerations in mind:

Physical Conditions:

Heat and cold, dryness and dampness, bending and twisting, vibration and shock, abrasion and crushing, and sun checking.

Chemical Conditions:-

Acids, sea water, oil and grease.

Electrical Conditions:

Effects peculiar to alternating current and direct current. The demands of the various sytems such as Lighting and Power, Interior Communication, Fire Control, and Radio, and the requirements of instrument and switchboard wiring.

The conditions listed often require specific insulating materials. The three main classes of insulation for electric cables used in marine work are rubber, cloth, and asbestos.

(a) Rubber or Synthetic Insulation resists moisture, is flexible and easy to handle but deteriorates rapidly when subjected to salt air.

This type of insulated cable is referred to as "flexible" and is used chiefly for portable leads to electrical equipment on moving machinery and turning units such as cranes, gun turrets, portable drills, etc.

Rubber insulated cables are not recommended for spaces subjected to excessive heat or moisture.

(b) Cloth Insulation is commonly referred to in marine work as the "cambric" type. This insulation is a closely woven cloth tape treated with different pliable insulation varnishes and oils. The composition depends upon the voltage that the cable will be subjected to and upon the conditions of installation. Insulated cable of this type is suitable for use under the majority of conditions found in marine electrical work that require fixed installations.

(c) Asbestos Insulation is used on cables commonly referred to in marine work as "flameproof" or "heat and flameproof" types. Cables with this type of insulation are used for fixed installations in ammunition magazines, ammunition handling spaces, inflammable stores, engine rooms, and fire rooms. Recently constructed naval vessels have "heat and flameproof" cables installed exclusively wherever fixed installations are required.

Cables with rubber, cloth, or asbestos insulation may be covered with an "armor" consisting of fine steel or aluminum alloy wires interwoven on the outside of the cable. This "armor" adds greater protection against mechanical injury to the installed cable; however, care must be exercised by the electrician that the fine wires of the armor are not broken by dragging or by bending too sharply during installation. Lead is also used as an outer sheath.

However, some of these materials have been superseded, or their use curtailed, because of the conservation program of critical materials. Often, too, insulating materials have been found which are superior in the particular application; e.g., the Navy Department now specifies a synthetic resin ("Neoprene" and "Flamenol" are two such examples) in lieu of rubber. Synthetic resin under tests has proven impervious to oils, most acids, and seawater, and is not as subject to sun checking. In view of the foregoing, cables having rubber insulated conductors or sheathing have been deleted, with but few exceptions.

However, the treatment of the deleted types of cables is considered necessary here together with those types superseding them in view of the fact that all naval vessels except the most recently constructed, are predominantly equipped with the former types of electric cables.

SELECTION AS TO CLASS AND TYPE

In general there are three classes of cables: (I) Unit Conductors and Wires, (II) Cables for Repeated Flexing Service, and (III) Cables for Non-flexing Service.

Types are segregated into Heat- and Flame-Resistant, Oil-Resistant insulations and under a miscellaneous grouping, "Other Types." The latter includes all the rubber, cloth and enamel insulations which, as noted above, have been deleted except as specifically approved by the Bureau of Ships.

CLASS I: UNIT CONDUCTORS AND WIRES

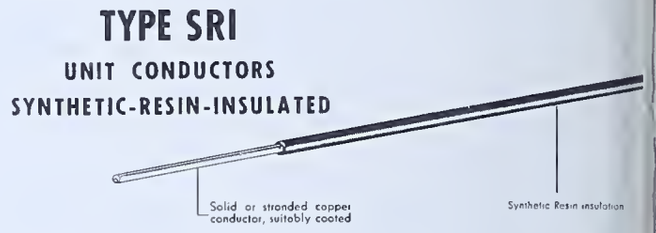
This class of cable is used for the wiring of switchboards and distribution panels, the internal wiring of instruments, metering gauges, bells, etc., and the external leads of measuring instruments and meters.

1. HEAT- AND FLAME-RESISTANT TYPES of unit conductors listed below used as insulation:- asbestos, glass braid, synthetic resins or a combination of the same. Where specified, code coloring is used. (*)

SRI Synthetic-resin-insulated.

SRIB Synthetic-resin-insulated, braided.

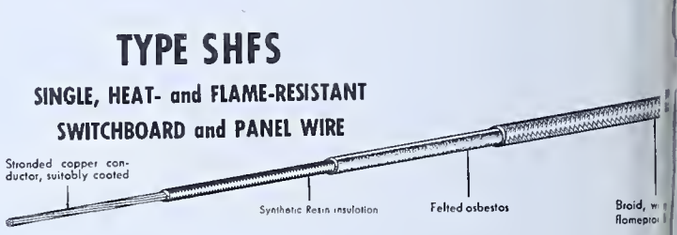
SRIG Synthetic-resin-insulated, glass braid.



SHFS Single-conductor, heat- and flame-resistant switchboard and panel wiring.

SHFW Single-conductor, heat- and flame-resistant.

*DHFW Double-conductor, heat- and flame-resistant.

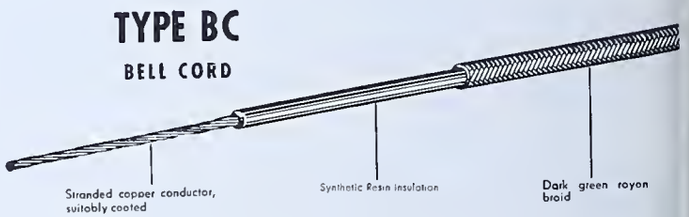


2. OTHER TYPES of unit conductors are enamel and synthetic resin insulated with silk or rayon braid serving, or as in the instance of SFPS* rendered flame-retarding while not resistant to heat and flame. (Refer to Subhead 1 above).

TSW Telephone switchboard wire.

BC Bell cord.

SFPS Single-conductor, flameproof, switchboard wiring.



CLASS II: CABLES FOR REPEATED FLEXING SERVICE

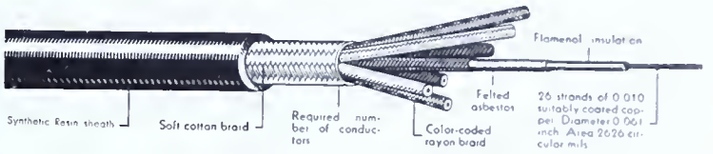
This class of cable is employed (1) for leads for connection to portable electric apparatus, (2) for permanent installation where the leads are liable to repeated flexing of a very severe nature, (3) where maximum resistance to mechanical abrasion, and moisture are primary requisites; i.e., cables through turret spindles, boat hoist spindles and other revolving machinery and structures, and (4) to such electrical systems including Light and Power, Interior Communication, Fire Control, and Telephone circuits as may be mounted within these locations.

(A) TYPES:

1. HEAT- AND FLAME-RESISTANT TYPES are insulated as above (refer to I, subhead 1) with an added over-all sheathing of synthetic resin for the application to flexing service. Where specified, code coloring is used. (*) Three types, DRIA, TRIA, AND FRIA are armored to prevent mechanical abrasion.

*Color Coded

*MHFF Multiple-conductor, heat- and flame-resistant, flexible.
*TTHFF Twisted-pair, telephone, heat- and flame-resistant, flexible.
*DRI Double-conductor, resin-insulated.
*DRIB Double-conductor, resin-insulated, braided.
*DRIA Double-conductor, resin-insulated, armored.
*TRI Triple-conductor, resin-insulated.
*TRIB Triple-conductor, resin-insulated, braided.
*TRIA Triple-conductor, resin-insulated, armored.
*FRI Four-conductor, resin-insulated.
*FRIB Four-conductor, resin-insulated, braided.
*FRIA Four-conductor, resin-insulated, armored.

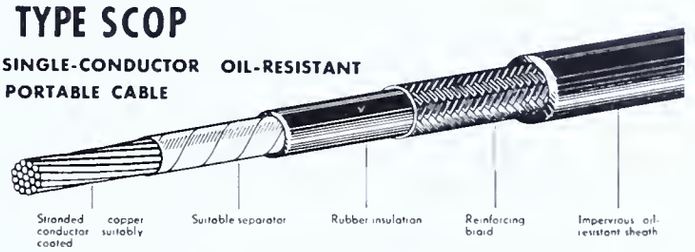

Flamenol insulation
Synthetic Resin sheath
Soft cotton braid
Required number of conductors
Felted asbestos
Color-coded rayon braid
26 strands of 0.010 suitably coated copper Diameter 0.061 inch Area 2626 circular mils

TYPE MHFF
MULTIPLE-CONDUCTOR
HEAT- and FLAME-RESISTANT
FLEXIBLE

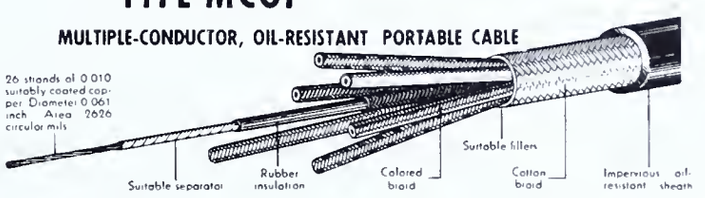
2. OIL-RESISTANT TYPES are rendered impervious to oils and greases, having a sheath of tough oil-resistant synthetic rubber. These types, however, are not heat- and flame-resistant. Where specified, code coloring is used. (*)

SCOP Single-conductor, oil-resistant, portable.
*DCOP Double-conductor, oil-resistant, portable.
*TCOP Triple-conductor, oil-resistant, portable.
*MCOP Multi-conductor, oil-resistant, portable.
*TTOP Twisted-pair, telephone, oil-resistant, portable.
*MCOS Multi-conductor, oil-resistant, shielded.

TYPE SCOP
SINGLE-CONDUCTOR OIL-RESISTANT
PORTABLE CABLE



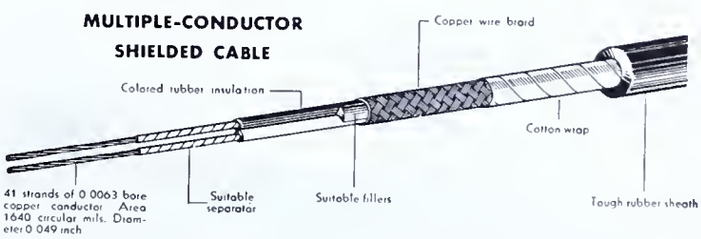
TYPE MCOP
MULTIPLE-CONDUCTOR, OIL-RESISTANT PORTABLE CABLE



3. OTHER TYPES are rubber insulated with a cotton braid, code colored, if required, and have an over-all sheath of rubber. The SCP, DCP, TCP, FCP, and MCP series have been superseded by oil-resistant series, SCOP, etc., or synthetic resin series, SRI, SRIB, DRI and DRIB, etc.

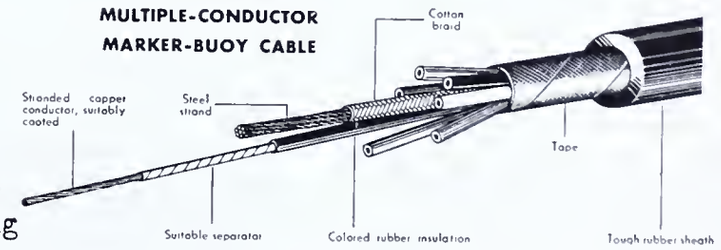
Type MCS is a multi-conductor portable cable having a copper braid shield under the over-all rubber sheathing. This type cable is for use with areas where a magnetic flux is present.

TYPE MCS
MULTIPLE-CONDUCTOR
SHIELDED CABLE


Copper wire braid
Colored rubber insulation
Cotton wrap
41 strands of 0.0063 bare copper conductor Area 1640 circular mils. Diameter 0.049 inch
Suitable separator
Suitable fillers
Tough rubber sheath

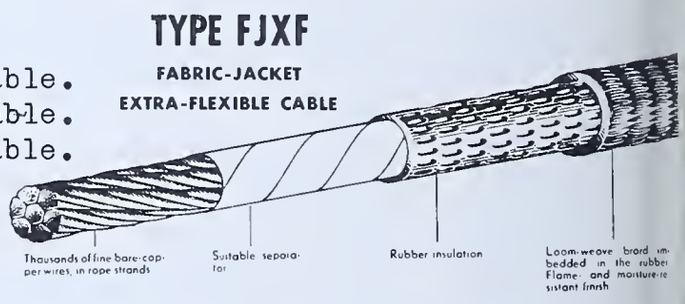
Type MCMB is a portable cable designed specifically for diving operations or, as the nomenclature would indicate, buoy service. This cable has a center core of corrosion-resistant steel stranded wire which is capable of withstanding a working load of approximately 750 pounds. A layer of cotton braid followed by seven conductors, code colored, sheaths the center steel core. This multi-conductor arrangement facilitates inter-communication during diving operations between the diving bell and the tender.

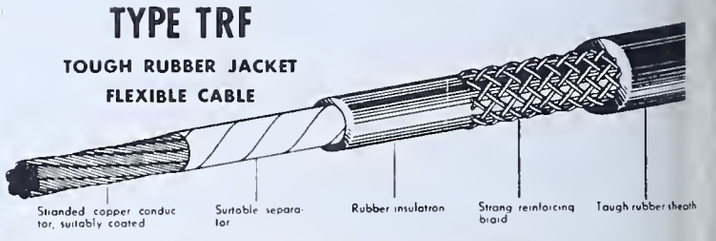
TYPE MCMB
MULTIPLE-CONDUCTOR
MARKER-BUOY CABLE



Types FJF, FJXF, TRF, TRXF are portable cables designed primarily for welding service. The first two types are fabric jacketed, the latter of the two, however, being extra-flexible (rope stranded). The second two types are rubber jacketed with the latter of the two being extra-flexible (rope stranded).

SCOP Single-conductor, oil-resistant, portable.
*DCOP Double-conductor, oil-resistant, portable.
*TCOP Triple-conductor, oil-resistant, portable.
*FCOP Four-conductor, portable.
*MCOP Multiple-conductor, portable.
MCS Multiple-conductor, shielded.
MCMB Multiple-conductor, marker-buoy.
*FJF Fabric-jacket, flexible.
*FJXF Fabric-jacket, extra-flexible.
*TRF Tough rubber jacket, flexible.
*TRXF Tough rubber jacket, extra-flexible.





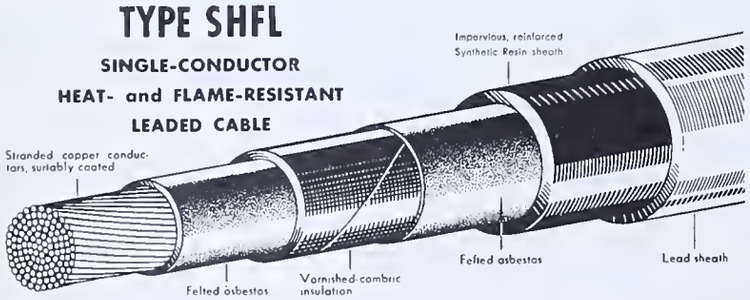
CLASS III: CABLES FOR NON-FLEXING SERVICE

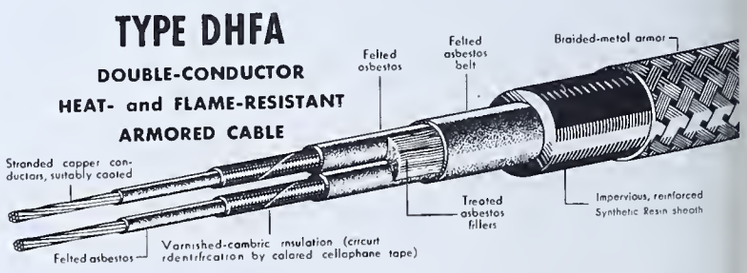
This class of cable is specifically applicable to fixed or permanent installation, and has a basket-weave metal armor or lead sheathing for protection against mechanical abrasion.

A. Types:

1. HEAT- AND FLAME-RESISTANT types listed have the same insulation as those previously noted, with the exception of SHFP (3) and (5), DHFP (3) and (5), and THFP (3) and (5). These types are additionally insulated with extra layers of varnished cambric for use on 3000 or 5000 volt circuits. Code colored cellophane is used as noted. (*).

SHFA Single-conductor, heat- and flame-resistant, armored.
SHFL Single-conductor, heat- and flame-resistant, leaded.

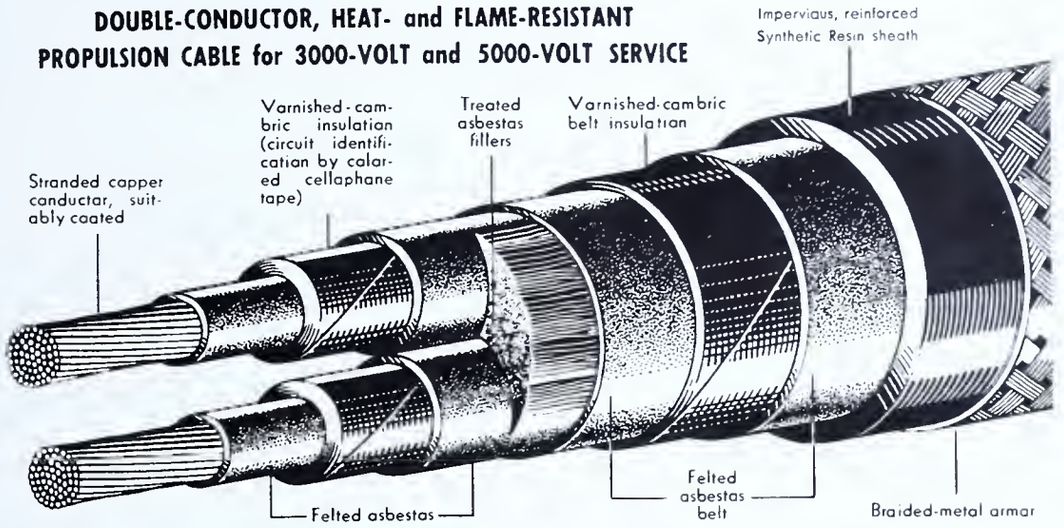




*DHFA Double-conductor, heat- and flame-resistant, armored.
*THFA Triple-conductor, heat- and flame-resistant, armored.
*FHFA Four-conductor, heat- and flame-resistant, armored.

TYPE DHFP (3) and DHFP (5)

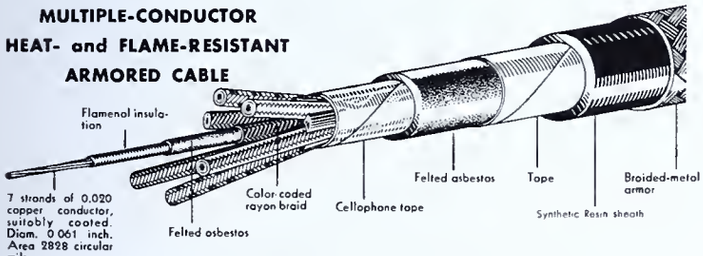
DOUBLE-CONDUCTOR, HEAT- and FLAME-RESISTANT PROPULSION CABLE for 3000-VOLT and 5000-VOLT SERVICE



*SHFP Single-conductor, heat- and flame-resistant, propulsion.
*DHFP Double-conductor, heat- and flame-resistant, propulsion.
*THFP Triple-conductor, heat- and flame-resistant, propulsion.
*SHFR Single-conductor, heat- and flame-resistant, radio.
*DHFR Double-conductor, heat- and flame-resistant, radio.
*THFR Triple-conductor, heat- and flame-resistant, radio.
*MHFA Multi-conductor, heat- and flame-resistant, armored.

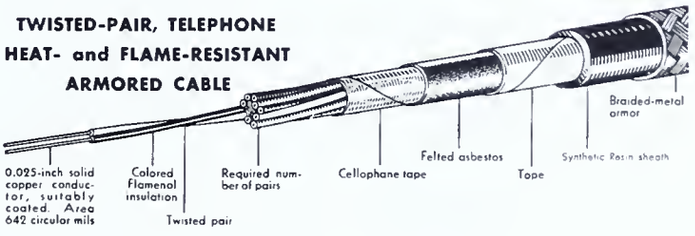
TYPE MHFA

MULTIPLE-CONDUCTOR HEAT- and FLAME-RESISTANT ARMORED CABLE



TYPE TTHFA

TWISTED-PAIR, TELEPHONE HEAT- and FLAME-RESISTANT ARMORED CABLE



*TTHFA Twisted-pair, telephone, heat- and flame-resistant, armored.
*PBLW Pyrometer-base lead wire.

2. OTHER TYPES not heat- and flame-resistant are listed below. The three types listed are lead sheathed, and one, SRSL, is copper braid shielded against magnetic fields and radio frequencies.

SRLL-4 Single-conductor, radio, low tension, leaded.
DRLL-4 Double-conductor, (twin), radio, low tension, leaded.
SRSL Single-conductor, radio, shielded and leaded.

TABLE I

CABLE SIZE DESIGNATIONS					
Light & Power		Interior Communication	Telephone Cable	Flexible Cables	
Actual C.M. area	Designation	Number of Conductors Designation	Number of Pairs of Conductors Designation	Actual C.M. area	Designation
2828	3	2	1	1120	1
4494	4	4	3	1616	1½
9030	9	7	5	2626	2
14350	14	10	10	3040	3
22820	23	14	15	4141	4
30780	30	19	20	6565	6
38950	40	22	25	9090	9
49020	50	26	30	14350	14
59940	60	30	40	22820	23
75850	75	37	50	30780	30
98820	100	44	60	40400	40
125050	125	Refer to	Refer to	151500	150
157380	150	Note 1	Note 2	252500	250
198860	200	for c. m.	for c. m.	414020	400
250710	250	area of	area of	829310	800
296660	300	conductor	conductor		
414020	400				
521970	500				
657860	650				
829310	800				
1046000	1000				
1662000	1500				

Note: 1. Cir. mil area of Interior Communications Cable Conductors = 2828 C.M.

2. Cir. mil area of Telephone Cable Conductors = 542 C.M.

SIZES OF MARINE ELECTRIC CABLES

I. Cable Size Designation:

The size of cables (conductor size and number of conductors) for marine application is determined by various factors.

A. Light and Power Cables:

Light and power cable designations refer to the circular mil area. When designating the size of light and power cables, regardless of type or number of conductors (single, two, three, or four), it is the practice to employ the first digit or the first few digits of the circular mil area of the cable (expressed in round numbers). Refer to Table I, columns 1 and 2.

The circular mil (c.m.) area of a conductor is determined by multiplying the diameter of the conductor (in decimals) by 1000 and squaring the product.

Example: The circular mil area of a conductor 1/8" in diameter is determined as follows:

$$1/8" = .125"$$

$$(.125 \times 1000)^2 = (125)^2$$

$$125 \times 125 = 15{,}625 \text{ c.m.}$$

Conductor sizes of light and power cable applications vary with rated load. For instance, a circuit carrying a total of 20 amperes would require a cable (heat- and flame-resistant type) having a conductor of 4,494 circular mils, or DHFA-4, whereas a total of 200 amperes necessitates the use of a conductor of 98,820 circular mils, or DHFA-100.

The number of conductors to be used in light and power cable applications is determined by the type current, the limitations in the handling, and by the specifications of the circuit design.

When applied to a direct current power distribution system, and light and power, cables usually consist of two conductors. Sometimes, however, a single conductor is used at the main distribution switchboard as a jumper, and usually the field lead of the main generator is a single-conductor cable. There are numerous instances in direct current lighting where a three- or even a four-conductor cable is specified.

Alternating current power circuits on most naval vessels are three-phase, three-wire, hence use a three-conductor cable. There are exceptions; e.g., compartment wall fan and radio receptacles, and also certain portable power apparatus which are single-phase, two-wire. All alternating current lighting branches are single-phase, two-wire.

Size Limitations:

For handling cable with facility there are certain limitations as to the physical size. In accordance with general practice dictated by the International Power Cable Engineers Association (IPCEA), cable manufacturers do not manufacture a three-conductor having a circular mil area (each conductor), exceeding 500,000. Navy Specification 15C1 (INT) lists two and three-conductor cables up to and including 400,000. When cable conductor needs exceed these sizes the circuit design will revert to single-conductor cables having the requisite circular mil area. A triple conductor heat- and flame-resistant armored - 400 (THFA-400) weighs approximately six pounds per foot. If a three-conductor cable of 650,000 circular mil area were required, the weight would probably exceed 7 pounds per foot and the difficulty in handling is obvious. Also, the cable fittings, such as stuffing and deck tubes, would mount in size and weight with a corresponding increase in the difficulty of packing.

B. Interior Communication Cables:

Interior communication cable designations refer to the number of conductors. Therefore, a multiple-conductor, heat- and flame-resistant armored cable, 10 conductors, would be designated as an MHFA-10. (Refer to Table I, columns 3 and 4.)

The conductor size of telephone and interior communication cables never varies, as the load requirements are small and constant.

C. Twisted-Pair Telephone Cables:

Telephone cable designations refer to the number of pairs of conductors. Therefore, a twisted-pair, telephone, heat- and flame-resistant, armored cable, 10 pairs, would be designated as a TTHFA-10. (Refer to Table I, columns 5 and 6.)

II. Cable Diameter

Over-all (outside) diameter of cable varies according to the type of cable, and the number and size of conductors.

The physical size of cable, indicated by the outside diameter, may vary from 1/32" to 1/16" for identical classes, types, and sizes produced by different cable manufacturers. There is, however, sufficient similarity to permit the selection of a lettered size terminal or stuffing tube, cable bushing or clamp that will be satisfactory for a particular class, type and size of cable. Refer to Table I, Unit 11.

However, in making cable straps, a definite cable measurement must be taken from the job in order to select the proper forming die, thus insuring a mechanically compact installation. Refer to Unit 21.

TABLE I

COLOR CODE FOR MULTIPLE CONDUCTOR CABLE

(1 to 44 conductors inclusive)

COND.	BASE	TRACER	TRACER
1	Black		
2	White		
3	Red		
4	Green		
5	Orange		
6	Blue		
7	White	Black	
8	Red	Black	
9	Green	Black	
10	Orange	Black	
11	Blue	Black	
12	Black	White	
13	Red	White	
14	Green	White	
15	Blue	White	
16	Black	Red	
17	White	Red	
18	Orange	Red	
19	Blue	Red	
20	Red	Green	
21	Orange	Green	
22	Black	White	Red
23	White	Black	Red
24	Red	Black	White
25	Green	Black	White
26	Orange	Black	White
27	Blue	Black	White
28	Black	Red	Green
29	White	Red	Green
30	Red	Black	Green
31	Green	Black	Orange
32	Orange	Black	Green
33	Blue	White	Orange
34	Black	White	Orange
35	White	Red	Orange
36	Orange	White	Blue
37	White	Red	Blue
38	Brown		
39	Brown	Black	
40	Brown	White	
41	Brown	Red	
42	Brown	Green	
43	Brown	Orange	
44	Brown	Blue	

Approved Color Code TTHFA Cable

Approved GE Construction No. 5

1st Conductor	2nd Conductor	1st Conductor	2nd Conductor
1. Black	White	31. Green	Brown
2. Black	Red	32. Green	Yellow
3. Black	Green	33. Green	Dark Blue
4. Black	Brown	34. Green	Pink
5. Black	Yellow	35. Green	Orange
6. Black	Dark Blue	36. Green	Purple
7. Black	Pink	37. Green	Light Blue
8. Black	Orange	38. Green	Gray
9. Black	Purple	39. Brown	Yellow
10. Black	Light Blue	40. Brown	Dark Blue
11. Black	Gray	41. Brown	Pink
12. White	Red	42. Brown	Orange
13. White	Green	43. Brown	Purple
14. White	Brown	44. Brown	Light Blue
15. White	Yellow	45. Brown	Gray
16. White	Dark Blue	46. Yellow	Dark Blue
17. White	Pink	47. Yellow	Pink
18. White	Orange	48. Yellow	Orange
19. White	Purple	49. Yellow	Purple
20. White	Light Blue	50. Yellow	Light Blue
21. White	Gray	51. Yellow	Gray
22. Red	Green	52. Dark Blue	Pink
23. Red	Brown	53. Dark Blue	Orange
24. Red	Yellow	54. Dark Blue	Purple
25. Red	Dark Blue	55. Dark Blue	Light Blue
26. Red	Pink	56. Dark Blue	Gray
27. Red	Orange	57. Pink	Orange
28. Red	Purple	58. Pink	Purple
29. Red	Light Blue	59. Pink	Light Blue
30. Red	Gray	60. Pink	Gray

SAFETY PRACTICES

Whenever cable is handled the following rules for personal safety should be observed:

1. Wear leather gloves to prevent injury from the sharp ends of the braided armor.

2. Secure help on heavy reels or cables. Do not attempt to roll or mount a reel of cable alone.

3. Place reel supports on a level base. When the reel is to be mounted on cable jacks, trestles, or cable frame, select a hard, smooth, level surface to prevent tilting. This is important when handling large reels.

4. Do not pull the cable off the reel too fast; this has a tendency to make the reel sway and may cause it to topple over.

5. Be sure the pipe or bar support through the reel is sufficiently strong to carry the weight.

6. After centering the bar or pipe on the trestles, drive heavy nails or nail wooden blocks on either side of the bar or pipe to keep it from rolling off. See Fig. 1.

7. When using a cable frame:

   a. Place it over the reel.
   b. Insert either a bar or pipe through the reel.
   c. Raise the frame until the bar or pipe can be placed through the supporting lugs of the frame.
   d. Raise the frame until the reel is off the ground at a safe angle for pulling the cable. See Fig. 2. Be sure that the front and back of the frame are not placed in a position which might allow the support to slide.

8. Always have at least one assistant stand by the reel to help pay the cable out and steady the reel, no matter what reel mounting is employed.

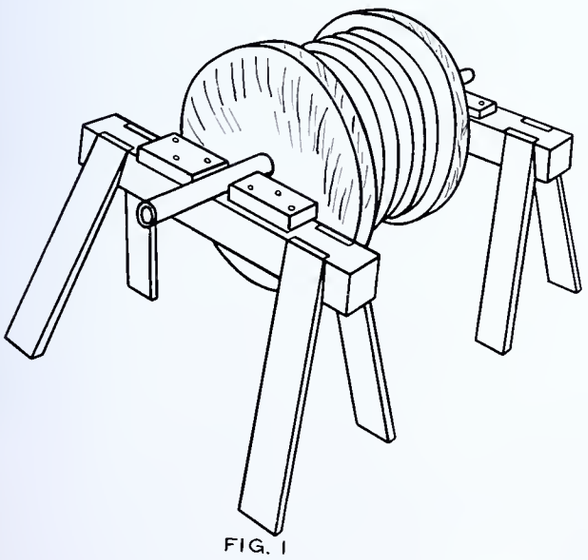


FIG. 1

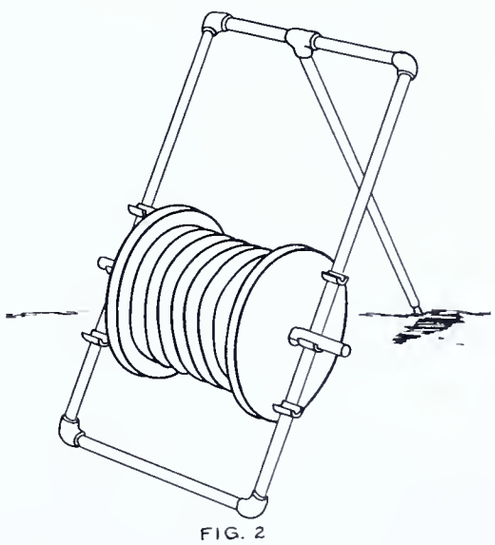


FIG. 2

PREPARATION AND PRESERVATION OF CABLE

Introductory Information:

Cables are shipped on reels with size and type marked on the reel. Reels should be mounted on cable jacks, trestles, or cable frames so they will turn freely when the mechanic reels the cable off to the desired length.

Care should be exercised by the mechanic during this procedure to eliminate kinks or twists in the cable.

Specifications:

Electrical cable shall be kept free from moisture at all times, and from dust, dirt, or any element that will promote surface leakage.

In the interval between its receipt from the cable manufacturer and its actual installation aboard ship, all electrical cable shall be stored where it will be adequately protected from the weather and from such extremes of temperature as are likely to hasten deterioration. The transfer from a cold to a much warmer location shall be accomplished in such a manner as to reduce moisture absorption by condensation to a minimum.

In the handling of electrical cable both prior to and during its installation aboard ship, care should be taken to avoid abrasion, crushing by blows or kinks due to twisting and bending too sharply without aid of mandre., or other damage. Cable is particularly susceptible to damage when very cold. The contact of cables with water, lubricating oil, or grease shall be carefully avoided.

No damaged cable shall be installed. Any cable damaged during or subsequent to its installation aboard ship shall be removed or replaced.

Whenever electrical cable is cut into lengths for the purpose of installation, all cut ends, whether on the lengths being installed or on the cable remaining on the reels or in coils, shall be sealed in a suitable manner to prevent the entrance of moisture into the interior of the cable via the cut ends. The method is explained in this unit.

It cannot be too strongly emphasized that such cut ends are the most vulnerable portions of the cable. Any failure to observe the necessary precautions at the proper time may result in a bottling up of moisture, entailing subsequent service hazards.

Tools and Equipment:

Leather gloves
Hack saw
Screw driver
Rule - 6 ft.
or
Steel Tape

Proper size and type of cable
Cable jacks, trestles or cable frame

Procedure:

1. Determine from the drawing or sketch, the proper size, type and length of cable required.

2. Select a clear space in which to reel off cable.

3. Mark off in this space the desired length of cable, using a six-foot rule or measuring tape.

4. Mark the space off along the working area in five-foot lengths.

5. Roll the reel to one end of the cleared space and mount it on cable jacks, trestles, or cable frame.

6. Pull free end of cable off the reel to the proper length.

7. Cut the cable through with a hack saw. See Fig. 3.

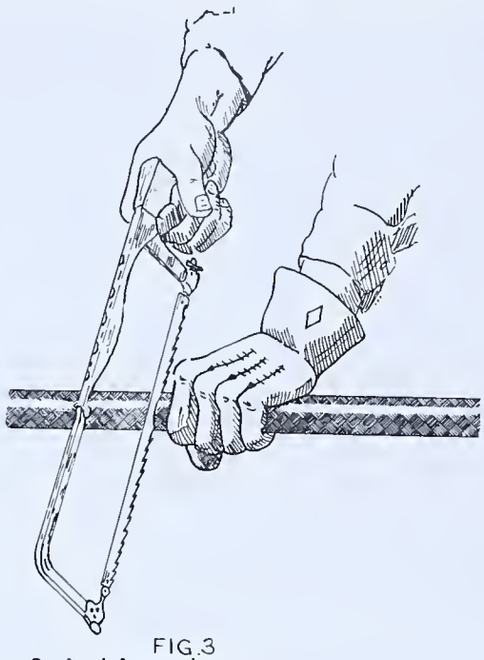


FIG. 3

8. Tape cable ends with friction tape.

   Note: Do this also to the free end of the cable that is still on the reel, and dip in hot bees-wax. This operation prevents moisture from entering the interior of the cable via the cut ends. If cut length is not to be used immediately, wax the ends of it also.

9. Roll up the cut length of cable and tie both ends with marlin to permit the mechanic to carry the cable to the job with the minimum amount of difficulty.

10. At the place of installation, unroll the cable and lay it out straight, suspend loosely in the space designated and have a painter apply one coat of specified paint to the cable. Allow paint to dry.

11. When long lengths of cable are to be installed, prepare a "head" on one end of cable as follows:

    a. Loosen the armor of the cable by prying action with a screw driver and push back the armor for a distance of four or five inches. See Fig. 4.

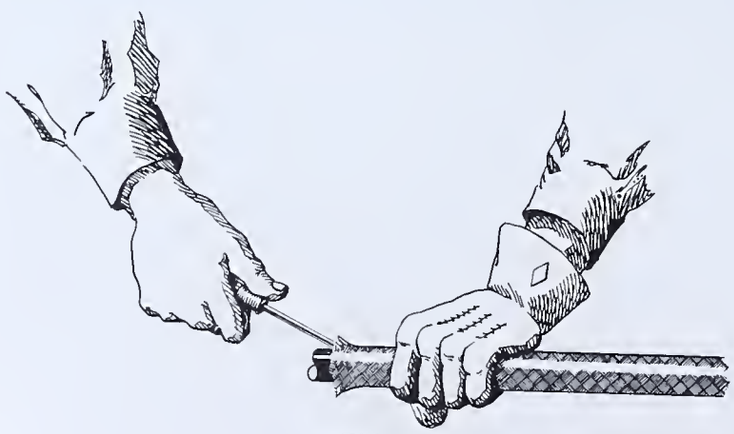


FIG. 4

b. Cut off the cable at this point with a hack saw. See Fig. 5.

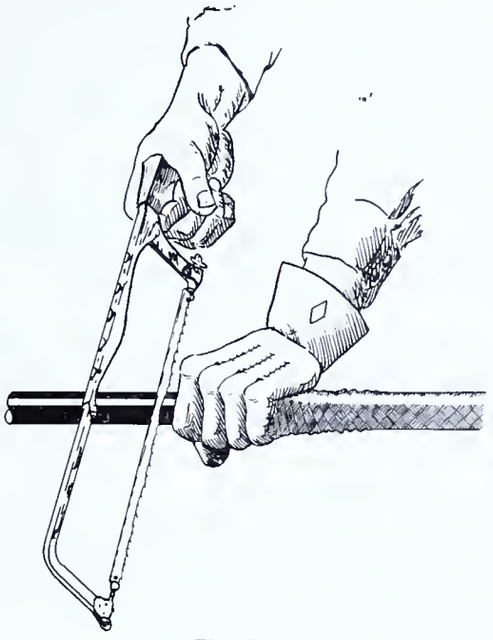


FIG. 5

c. Pull the armor forward over the cable end and twist into a point with a pair of pliers. See Fig. 6. (This method is used when the cable is to be pushed through tubes and bushings or holes in beams, etc.)

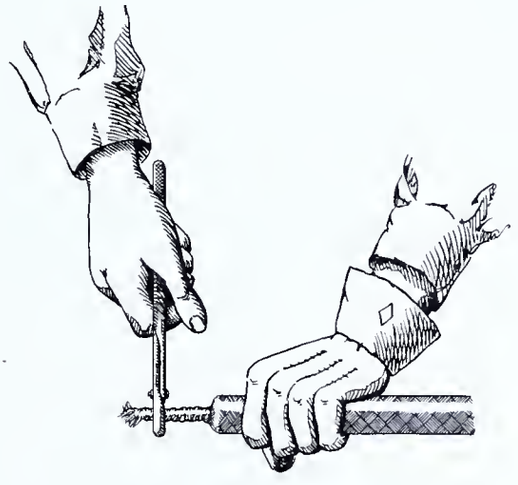


FIG. 6

When the cable is to be pulled in a cable run, the armor extending beyond the cable end is fashioned into an "eye" and taped. A rope is then secured to this eye for pulling the cable. See Fig. 7. Other devices such as a mesh cable puller may be provided for this purpose, in which case the "eye" is unnecessary.

FIG. 7

PULLING CABLE

1. When installing cable, care should be taken to prevent chafing or damaging the braided or armored cover. At the beginning of a run a piece of scrap sheet metal (sharp edges removed) should be bent and placed on the first cable rack to permit the cable to slide over it without injury. See Fig. 8.

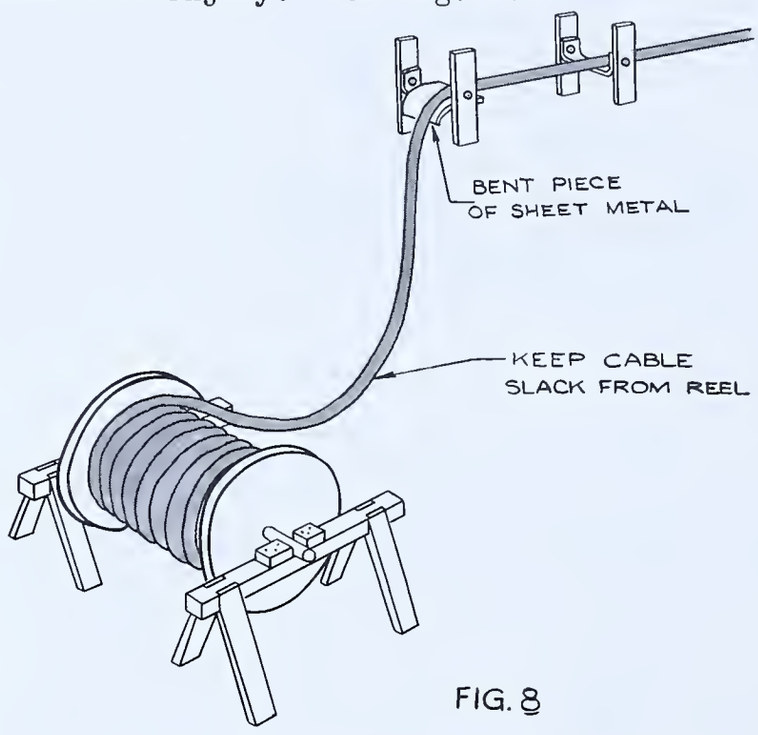
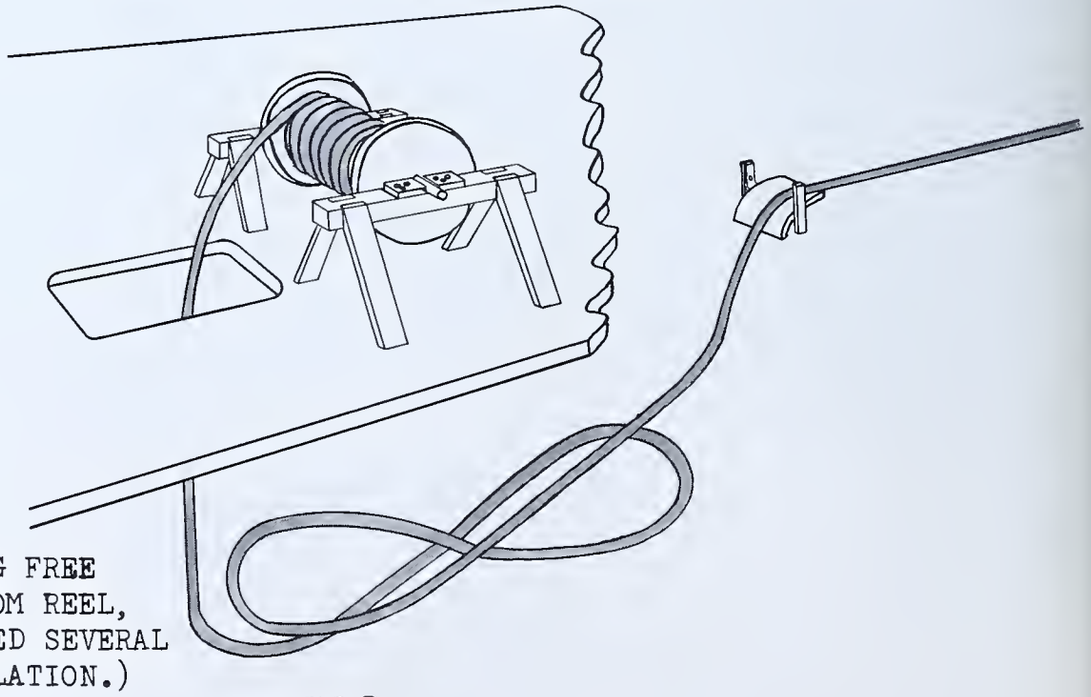


FIG. 8

2. When the cable is to be pulled in on racks, assistants should be stationed at convenient points along the run to help advance the cable. The cable should be pulled or pushed only as fast as the assistant or assistants at the reel pay it out. Frequently a length is paid out from the reel to facilitate this operation. See Fig. 9.



METHOD OF PROVIDING FREE LENGTH OF CABLE FROM REEL, (WHICH MAY BE PLACED SEVERAL DECKS ABOVE INSTALLATION.)

FIG. 9

3. It is extremely important that there are no kinks or twists in the able as it is pulled or pushed.

4. Where the cable run takes a bend, it is advisable to pull a loop in the cable at that point and use the same methods as are used in the beginning of the run. See Fig. 7.

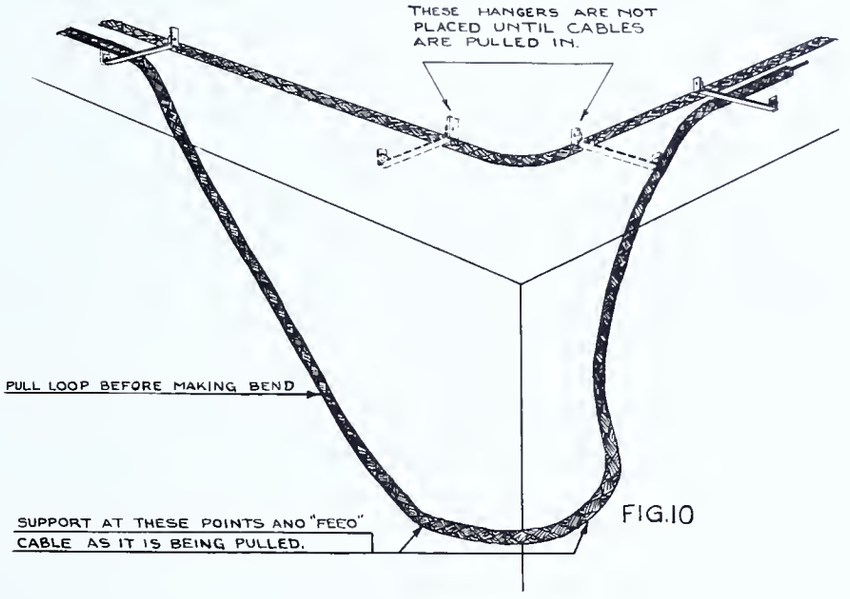

THESE HANGERS ARE NOT PLACED UNTIL CABLES ARE PULLED IN.
PULL LOOP BEFORE MAKING BEND
SUPPORT AT THESE POINTS AND "FEED" CABLE AS IT IS BEING PULLED.

FIG.10

Note: It is advisable to use the same method when entering a stuffing tube, kick pipe, or bushing. See Fig. 8.

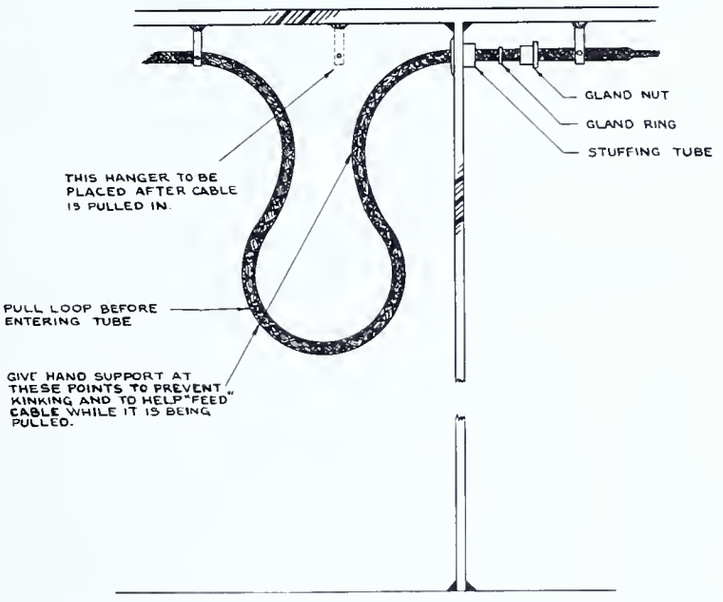

GLAND NUT
GLAND RING
STUFFING TUBE
THIS HANGER TO BE PLACED AFTER CABLE IS PULLED IN.
PULL LOOP BEFORE ENTERING TUBE
GIVE HAND SUPPORT AT THESE POINTS TO PREVENT KINKING AND TO HELP "FEED" CABLE WHILE IT IS BEING PULLED.

FIG. 11

5. Whenever the cable has to pass by a sharp or protruding object, always provide a buffer of some sort, either wood or sheet metal with rounded edges, to protect the cable.

6. When the cable is pulled off the reel, be sure that enough cable is left at either end of the run, to permit connecting to equipment.

HOW TO BEND CABLE

Introductory Information:

To avoid damage when bending in cold weather, cables are grouped into three classes with minimum safe bending temperatures as follows:

1. 40° F. for cables up to $1\frac{1}{4}$" dia.
2. 50° F. for cables larger than $1\frac{1}{4}$" dia. but less than 2".
3. 55° F. for cables over 2" dia.

Cables shall not be subjected to bends of smaller radius than indicated in the diagram on Page 35. In general, a cable should not be bent to a smaller radius than six times its own diameter. This figure is known as a cable's "minimum bending radius". Horizontal bends of large radius (particularly in locations subjected to probable damage by personnel or by vibration) are supported by a suitable mechanical member and the cable securely attached thereto at frequent intervals.

To obtain the greatest degree of compactness practicable, those types and sizes of cables having the smallest permissible bending radius should be placed on the inside of the cable group, allowing the cables having larger permissible radius to be placed on the outside of the group.

How to determine minimum bending radius from the curves shown on next page

(a) Determine type of cable used and its outside diameter.
(b) Locate the point, along the horizontal scale, corresponding to the outside diameter of the cable.
(c) Project this point vertically until it intersects with the curve designated for the type of cable used.
(d) Determine the minimum bending radius by projecting this point of intersection horizontally to the vertical scale.

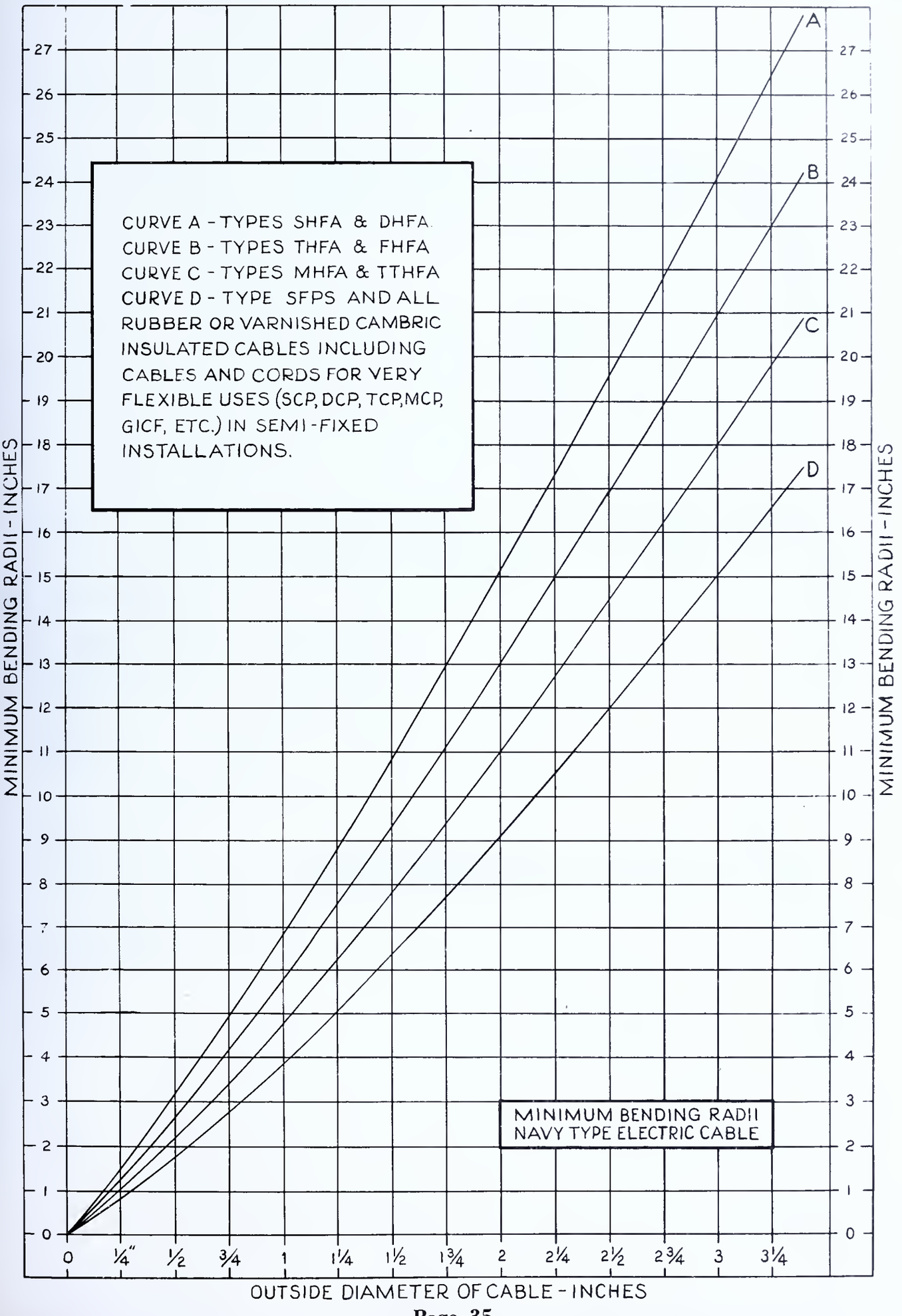
Example:

Problem: Determine the minimum bending radius of a DHFA cable having a 1" outside diameter.

Answer: (a) Locate 1" mark along "Outside Diameter of Cable" scale on the curves.
(b) Project vertically along the 1" line to the point of intersection with curve "A".
(c) Project point of intersection of curve horizontally to the minimum bending radius curve.
(d) Minimum bending radius is determined as 7-1/8".

Tools and Equipment:

Mallet (rawhide)
Leather gloves
(Hardwood Pry) fulcrum (6" to 36" long, depending upon size of cable).
$\frac{1}{2}$" Hemp Rope (15 ft. long) (for sling)
Hardwood wedge (16" x 4" x 1") tapered on end.


CURVE A - TYPES SHFA & DHFA.
CURVE B - TYPES THFA & FHFA
CURVE C - TYPES MHFA & TTHFA
CURVE D - TYPE SFPS AND ALL RUBBER OR VARNISHED CAMBRIC INSULATED CABLES INCLUDING CABLES AND CORDS FOR VERY FLEXIBLE USES (SCP, DCP, TCP, MCP, GICF, ETC.) IN SEMI-FIXED INSTALLATIONS.
A
B
C
D
MINIMUM BENDING RADII NAVY TYPE ELECTRIC CABLE
MINIMUM BENDING RADII - INCHES
0 27
1 26
2 25
3 24
4 23
5 22
6 21
7 20
8 19
9 18
10 17
11 16
12 15
13 14
14 13
15 12
16 11
17 10
18 9
19 8
20 7
21 6
22 5
23 4
24 3
25 2
26 1
27 0
0 ¼" ½ ¾ 1 1¼ 1½ 1¾ 2 2¼ 2½ 2¾ 3 3¼
OUTSIDE DIAMETER OF CABLE - INCHES

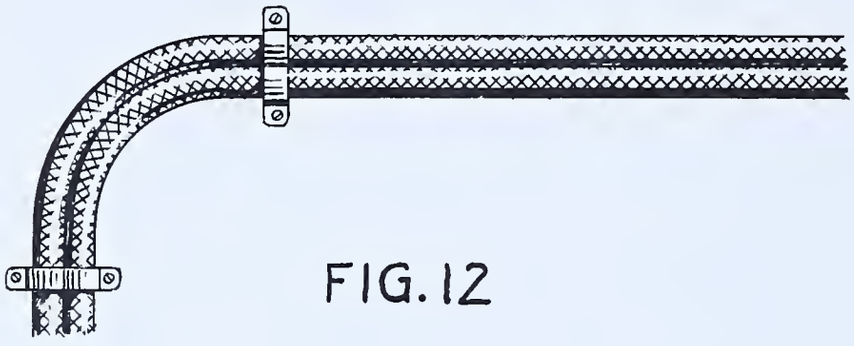


FIG. 12

RIGHT PROCEDURE

90° bend.

FIG. 13

WRONG PROCEDURE

Bend is too high, distorts cable and throws it out of line. Most likely to damage insulation or armor.

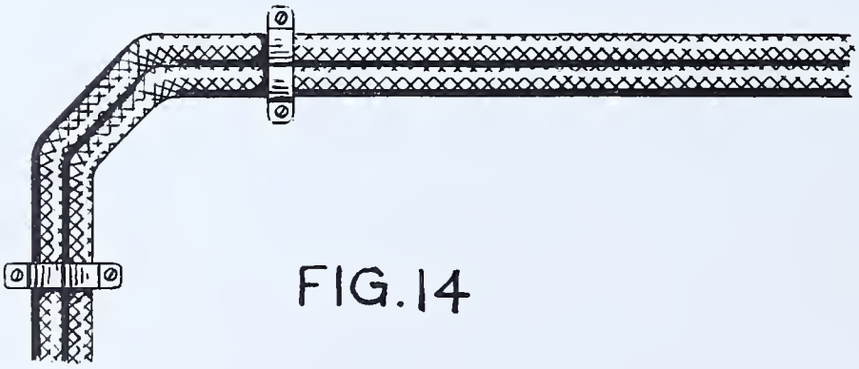


FIG. 14

WRONG PROCEDURE

Bend is too flat, is not neat, shows poor workmanship.

1. Small cable may be shaped into a bend with the aid of a rawhide mallet and hardwood wedge. The wedge is used to transmit impact into places that the mallet cannot enter.

2. On larger cables it is sometimes necessary to use a sling and a large pry stick to help in shaping the cables. The method will depend on conditions encountered.

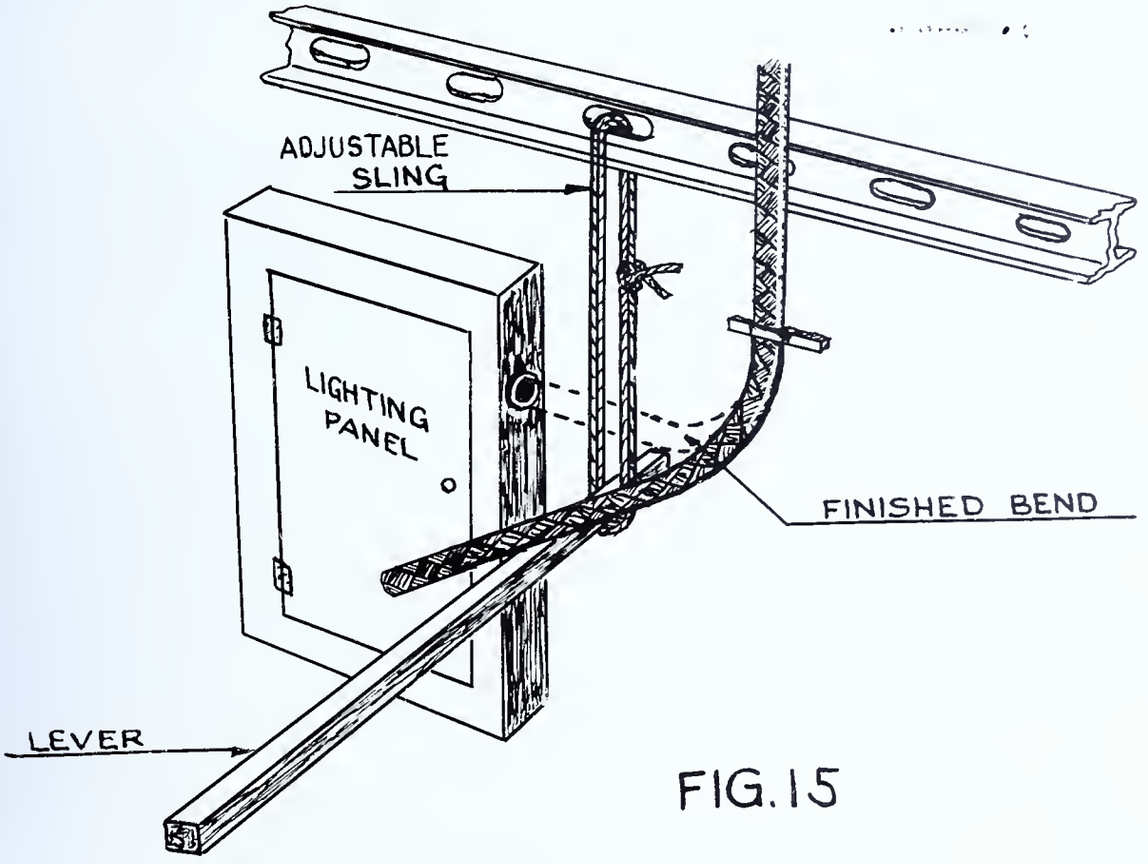


FIG. 15

3. In cold weather it may be necessary to apply heat to the cable by the use of a plumber's blow torch. Care should be exercised by the mechanic when applying the heat so as not to injure the armor or insulation. See diagram on Page 35, Introductory Information for safe bending temperatures.

TESTS FOR CONTINUITY, SHORTS, AND GROUND

Continuity means continuous, without interruption. In electrical work it applies to a "closed circuit". Continuity tests are conducted wherever extensive electrical installations are made, to insure against "open circuit" or wrong connections before operating voltages are applied. It is good practice to test continuity before and after making connections.

Short tests are made to ascertain the electrical "independence" of each conductor, in order to check against the possibility of two conductors touching through defective or broken insulation. Serious damage may result from shorted or grounded connections.

Ground tests are made to be sure that the outer sheathing of the cable is not in contact with the conductors it contains, and also to determine insulation resistance. The megohmmeter is usually used for this purpose. When insulation resistance tests are too low it is inadvisable to use the faulty conductor. Insulation which tests 5 megohms or more is accepted as satisfactory. Cable which tests zero has ruptured insulation or is otherwise grounded and should not be used.

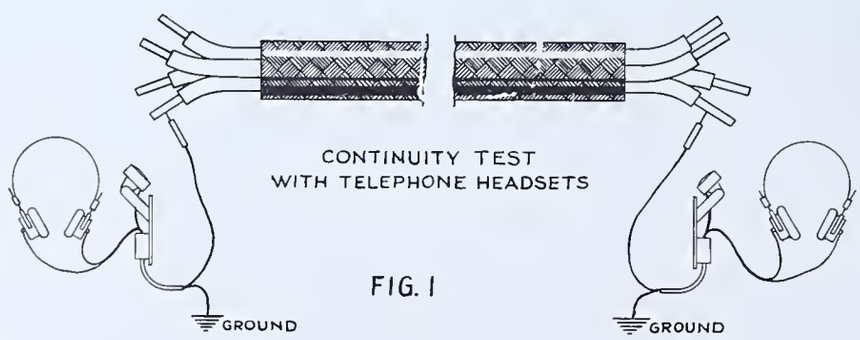
The most commonly employed devices and their uses in conducting these tests on shipboard are listed below.

1. Battery-powered telephone headsets

a. Test for continuity:

Two headsets and two men are required, one at each end of the cable. One lead on each headset is grounded to the ship's metallic structure, thereby forming one leg of the circuit. See Fig. 1. The remaining lead on headset No. 1 is secured to a pre-selected color-coded wire in the cable. The free lead of headset No. 2 is connected to the pre-selected color-coded wire at the other end of the cable. There should be a click heard in the earphone of each headset, indicating continuity, meaning that the circuit is completed and conversation may be made over the telephones.

Once continuity has been established, the test men select another wire for test and repeat until all the wires in the cable are tested.



CONTINUITY TEST
WITH TELEPHONE HEADSETS

FIG. 1

This test may be performed by one man alone by twisting the paired cables together at one end and touching each of the paired conductors at the other end with the phone tips. See Fig. 2. Do not let the tips touch each other or a false indication of continuity will be obtained.

b. Test for Shorts (Crossed wires)

Following the continuity test the cable should be checked for shorts, as follows.

Test man #1 keeps his contact with the original wire and ground; test man #2 keeps one contact to ground and shifts the other phone tip to the various conductors adjacent to the original one. An indication of continuity (a click in the head phones) shows the presence of crossed wires, i.e. the other conductor which indicates continuity is making contact with the original one. Such combinations of wires shorted in this way must be suitably marked as bad, then cut back or twisted together and not used.

c. Test for grounded conductors

A third test is necessary to see if any cable is grounded to the sheath. This is done by one man; the method is as follows. See Fig. 3.

Ground one phone tip by touching it to the metal sheath of the cable, with the other tip touch all conductors of that cable which are adjacent to the sheath. Any indication of continuity shows a contact between conductor and sheath. Such a cable should not be used.

2. Lamp or buzzer and battery

Although the phone is preferred for testing because it is a quicker method, other devices may be used. The lamp or buzzer and battery is frequently used, particularly for "one-man" tests.

The conductors at one end of the cable are twisted into pairs according to color code and the lamp or buzzer and battery are connected at the other end of the cable as in Fig. 2.

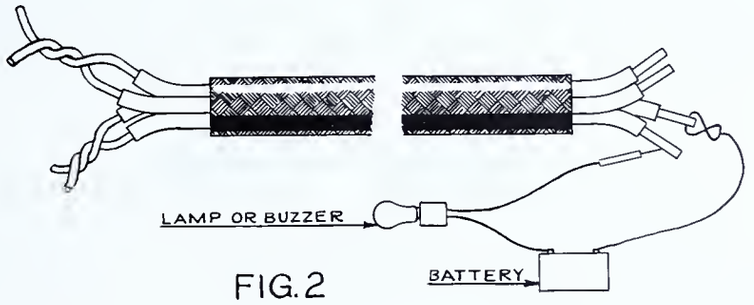


FIG. 2

a. Continuity tests

Connect the two ends of the lamp circuit to the two wires of the pair to be tested. Lighting of the lamp or the sound of the buzzer indicates continuity. Repeat for each pair of wires.

b. Test for Shorts

With the paired wires twisted as above (Fig. 2), establish the same circuit as shown there. Remove the lamp lead to the cable and touch that lead successively against all other conductors which are adjacent to the original pair. Indications of continuity demonstrate the presence of a short between the wires then being tested.

c. Test for grounded conductors

The wires need not be paired but may stay twisted if already together. Connect one lead from the lamp-battery circuit to the sheath of the cable. See Fig. 3. With the other lead successively touch the exposed conductors of the cable. Any indications of continuity show contact between the shield and the cable, indicating a grounded conductor. The wire showing such a ground, if twisted with its pair, should be untwisted to determine which one of that pair is grounded.

3. The Megohmmeter ("Megger")

The "megger" is an instrument used for determining electrical resistance values. It consists of an ohmmeter designed to read in megohms, (one megohm is a million ohms). A reading of zero indicates continuity, or flow of current; high instrument readings indicate resistance of the registered amount. The megger is usually used to test for grounds but may be used for the other tests.

a. Continuity tests

The wires so coded are twisted into pairs at one end of the cable. The megger is connected with one lead to each wire of the pair tested. The armature of the megger is turned to supply current flow through the cable. If there is continuity, which permits a free flow of current through the wires tested, the resistance will be so low that the megohmmeter will record it as zero. Continuity then is represented by a zero reading on the megger. A high reading indicates lack of continuity.

b. Test for Shorts

The procedure is the same as with the lamp. Place one lead of the megger to one wire of the pair just tested for continuity. Touch the wires of all adjacent conductors and turn the armature. A high resistance reading should be obtained indicating lack of continuity between such conductors.

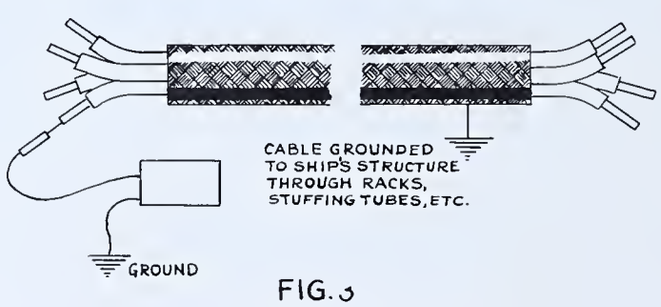


FIG. 3

c. Test for ground

The cable is usually not wired in pairs, although the test may be performed either way. See above, 2c. Connect one lead of megger to shield of cable or ground. See Fig. 3. Touch each conductor with the free lead. Zero reading indicates low resistance caused by the presence of a "ground", this shows faulty insulation and such cable cannot be used. Insulation should test more than 5 megohms to be accepted as satisfactory.

PART III

SKINNING, SERVING, AND LACING CABLES

UNIT 8 — HOW TO SKIN, SERVE, AND LACE A MULTI-CONDUCTOR CABLE TERMINATING AT A SWITCHBOARD — Page 42

UNIT 9 — HOW TO SKIN, SERVE, AND LACE A LIGHTING AND POWER CABLE TERMINATING AT A SWITCHBOARD — Page 46

UNIT 10 — HOW TO SKIN, SERVE, AND LACE A CABLE TERMINATING IN ENCLOSED EQUIPMENT — Page 48

HOW TO SKIN, SERVE, AND LACE THE END OF A MULTI-CONDUCTOR CABLE TERMINATING AT A SWITCHBOARD

General Information:

The preparation of the end of a cable terminating at a switchboard is an important part of the cable installation. A cable end that is properly prepared preserves the qualities of the insulation on the remainder of the cable and adds to the neatness of the work.

Lacing the end of a cable increases the efficiency of the workman while terminating the conductors, and adds to the neatness of the work.

Tools and Materials:

Skinning knife
Friction tape
Varnished cambric tape
Serving twine
Glyptol (insulating enamel)
Five-foot length, 10-conductor cable (multi-conductor armored) MHFA-10

How to Skin and Tape the End of a Cable

1. Wrap $1\frac{1}{2}$ to 2 turns of friction tape around the cable at the point from which the cable is to be skinned. See Fig. 1.

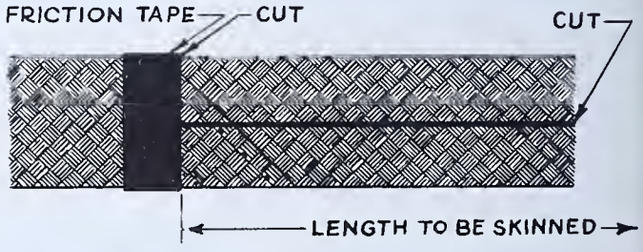


FIG.1

Note: This serves a two-fold purpose:
(a) Gives a guide for cutting.
(b) Holds ends of fine wires of armor in position, thereby preventing fraying.

2. Use skinning knive and cut through the armor around the circumference of the cable, using the tape as a guide; cut the armor from the tape line to the end of the cable. Remove the armor.

3. Cut through each succeeding layer of insulation, using approximately 3/4 of the diameter of the cable as the distance between each cut until the conductors are exposed (Fig. 2).

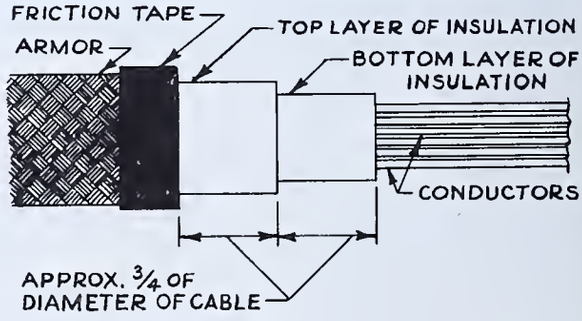


FIG.2

4. Wrap exposed insulation with
(1) a layer of varnished cambric tape, and
(2) a layer of friction tape.

Tape is to be wrapped to give a neat, tapered end to the cable, and each lap of tape should cover half of the previous lap. See Fig. 3.

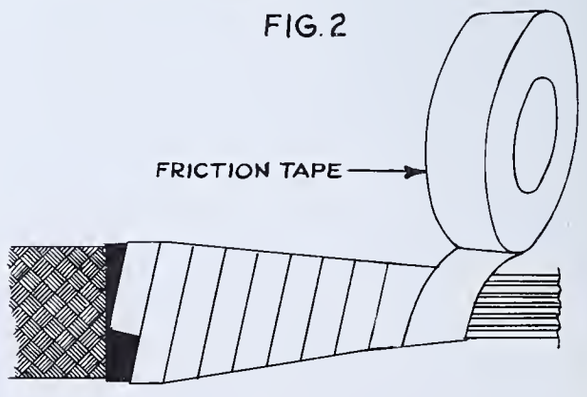


FIG.3

How to Serve a Cable Terminating at a Switchboard

1. Serve cable end by laying one end of the serving twine along the cable, away from the exposed conductors. See Fig. 4. Secure the serving twine to the cable with your thumb, at the end of the friction tape nearest the exposed conductors and 10 inches from the end of the serving twine. Wrap the twine around the cable (over the twine along the cable) leading away from the end of the cable.

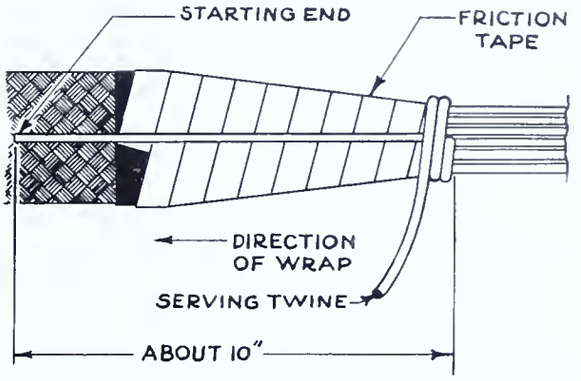


FIG 4

2. Make seven or eight turns, then lay the starting end (see Fig. 4) of the twine back over the wrapped portion, and continue serving to within $\frac{1}{4}$" of the other end of the friction tape.

3. At this point, form a loop with the starting end of the twine that will extend about 1" beyond the friction tape. See Fig. 5.

4. Continue to serve the cable over the loop until a position $\frac{1}{2}$" beyond the friction tape is reached.

5. At this point, insert the free end of the serving twine in the loop, and draw loop back under the serving. See Fig. 5.

6. Cut off ends of serving twine above the serving.

7. Apply a coat of "Glyptol" (insulating enamel) over the serving for moisture proofing and insulation protection.

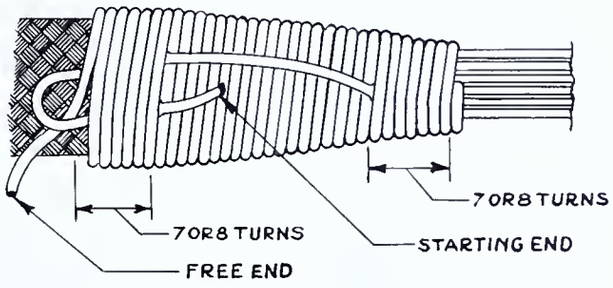


FIG.5

How to Lace a Multi-conductor Cable

1. Lace the conductors by starting approximately $\frac{1}{4}$" from the serving and tie a "slip" knot. Pull knot tightly around the conductors.

2. Select the black conductor and bend at right angles to the remainder of the conductors, 3/4" from the serving.

3. Tie a "lock" knot, 3/8" from the conductor at right angles.

4. Continue to "fan" the conductors (at intervals of 3/4") following the color code (Table I) and tie lock knots until two conductors remain.

5. At this point, tie a "lock" knot and a "slip" knot to finish the lacing job. See Fig. 6.

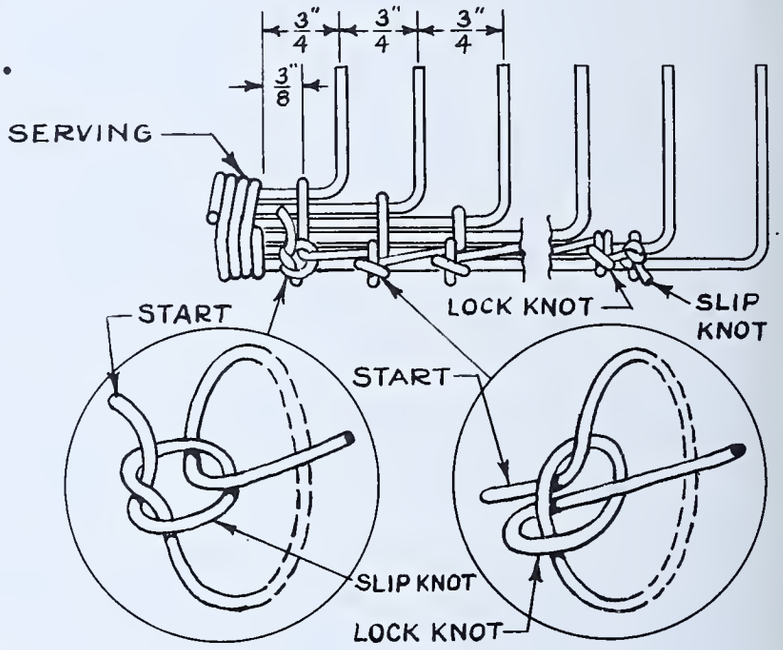


FIG. 6

Notes:

1. Conductors may be "fanned" either to tne left or to right, depending on which side of the switchboard the cable is terminated.

2. The distance between conductors is designated as 3/4" because that dimension is the usual spacing for terminals on terminal strips.

The finished job should have the appearance shown in Fig. 7.

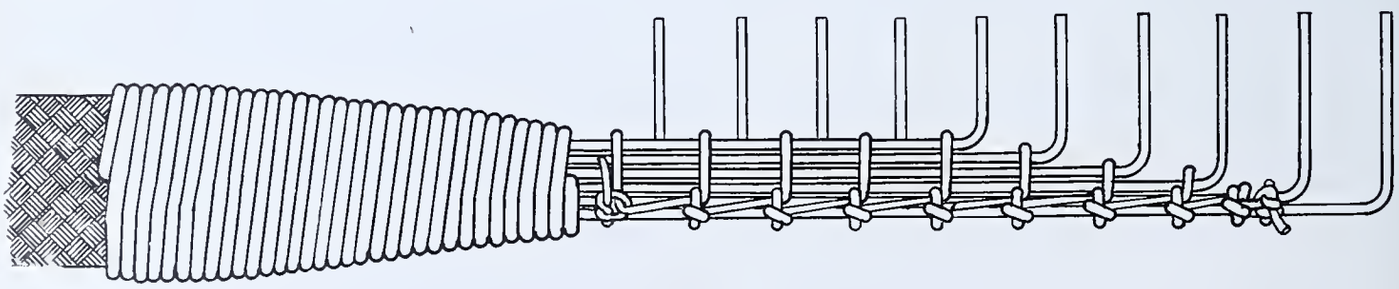


FIG. 7

QUESTIONS

Place the answers to these questions in your notebook or on form as directed by instructor.

1. What is the proper procedure for removing armor from a cable?
2. Outline the steps in removing various layers of insulation.
3. Explain the proper method of wrapping tape.
4. What kind of tape is installed next to the conductors?
5. How is a cable butt served?
6. What is Glyptol, when is it applied, and what purpose does it serve?
7. What type knots are used in lacing the conductors?
8. What determines the order of fanning the conductors?
9. What is the purpose of taping and serving a multi-conductor cable terminating at a switchboard?
10. What is the purpose of lacing a multi-conductor cable terminating at a switchboard?

HOW TO SKIN, SERVE, AND LACE A LIGHTING AND POWER CABLE TERMINATING AT A SWITCHBOARD

General Information:

The work on lighting and power cables differs from multi-conductor cables in that the conductors to be laced are more cumbersome, thereby requiring a different method of preparation.

Tool:

Skinning knife

Materials:

Friction tape
Fibrous glass tape
Varnished cambric tape
Serving twine
Liquid sodium silicate
Glyptol (red insulating enamel)
Type THFA-9 cable (5 ft.)

How to Skin, Tape, and Serve the End of a Cable:

1. Skin, tape, and serve the end of the cable as specified on Sheets 1 and 2 of Unit 8, adding a layer of fibrous glass tape between the varnished cambric tape and the friction tape. Use liquid sodium silicate for cementing the fibrous glass tape in place.

   Fibrous glass tape is used in preparing the ends of lighting and power cables that are subjected to 440 volts and more, because of its high dielectric strength.

   Varnished cambric and friction tapes are used on cables that are subjected to 220 volts or less.

How to Tape and Serve Lighting and Power Cable Conductors:

1. "Fan" the conductors by leaving 2-1/2 inches between centers, starting approximately 3" from the serving.

   Note: Distance between "fanned" conductors depends upon the specific application.

2. Wrap the entire length of the conductors with friction tape starting at the end of the serving. Tape is to be wrapped so that each successive lap covers half of the previous lap. See Fig. 1.

3. Apply coat of Glyptol over the friction tape, for moisture proofing and insulation protection.

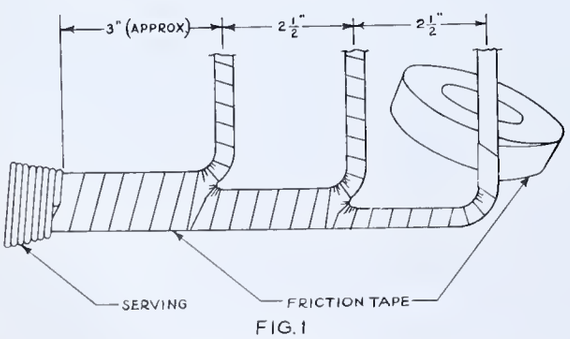


FIG. 1

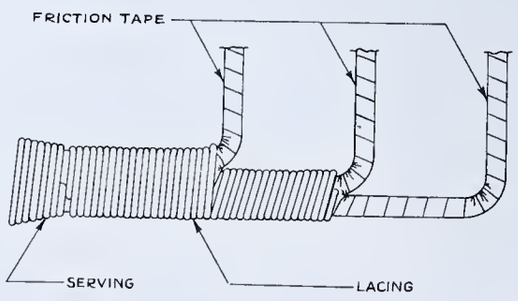


FIG. 2

4. Serve the conductors in the same manner as the cable was served, between the end of the cable serving, and the next to the last conductors. See Fig. 2.

Notes: a. Serving of the conductors of lighting and power cables in marine work is used on large cables only.

b. Taping only of the conductors is suitable for small lighting and power cables.

5. Apply a coat of Glyptol over the servings and over the tape on the conductors. The finished job should have the appearance shown in Fig. 3.

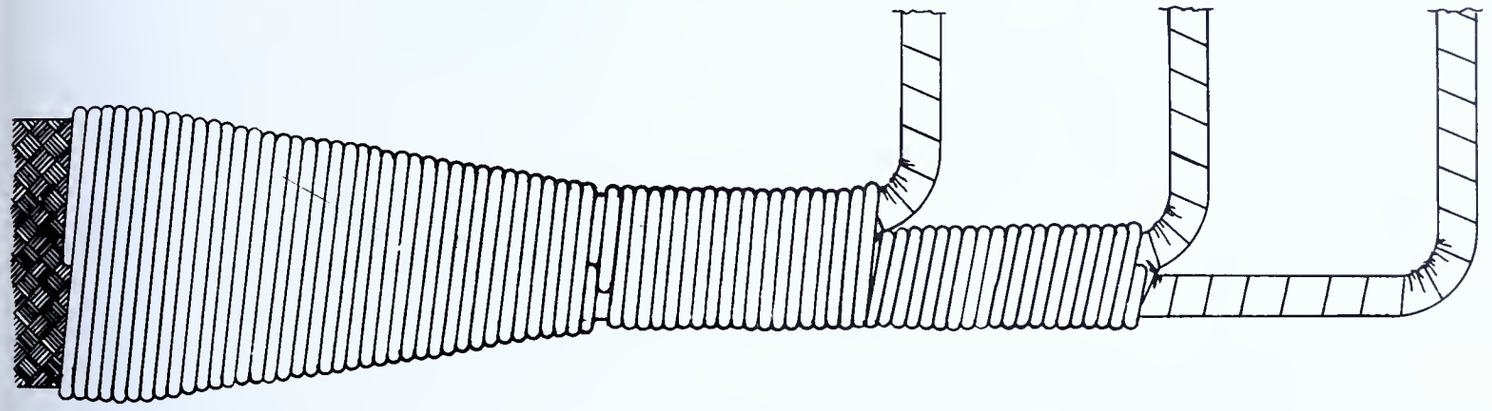


FIG.3

QUESTIONS

Place the answers to these questions in your notebook or on form as directed by instructor.

1. Name the kinds of tape and the order of application as used on the butt of a cable that is subjected to 440 volts and above.

2. Name in proper order the kinds of tape which are used on the butt of a cable that is subjected to 220 volts or less.

3. When are power and lighting cable conductors served?

4. When and where is Glyptol applied on power and lighting cables?

HOW TO SKIN, SERVE, AND LACE A CABLE TERMINATING IN ENCLOSED EQUIPMENT

General Information:

This process differs from that involved with cable terminating at switchboards in that the serving twine is replaced by a bushing or terminal tube. This unit places the cable in a terminal tube already installed.

Tool:

Skinning knife

Materials:

Friction tape
Glyptol (clear insulating enamel)
Serving twine
Type MHFA-10 cable (5 ft.)
Type THFA-9 cable (5 ft.)
Terminal tube, Type XXI, Size J
Cable enclosure (1/4" sheet steel may be used to simulate enclosure)

How to Skin and Prepare the End of a Cable

1. Wrap 1-1/2 to 2 turns of friction tape around the cable at the point from which the cable is to be skinned. See Fig. 1.

   Note: This serves a two-fold purpose;
   (a) Gives a guide for cutting,
   (b) Holds ends of fine wires of armor in position thereby preventing fraying.

2. Use skinning knife and cut through the armor around the circumference of the cable, using the tape as a guide. Cut the armor from the tape line to the end of the cable. Remove the armor.

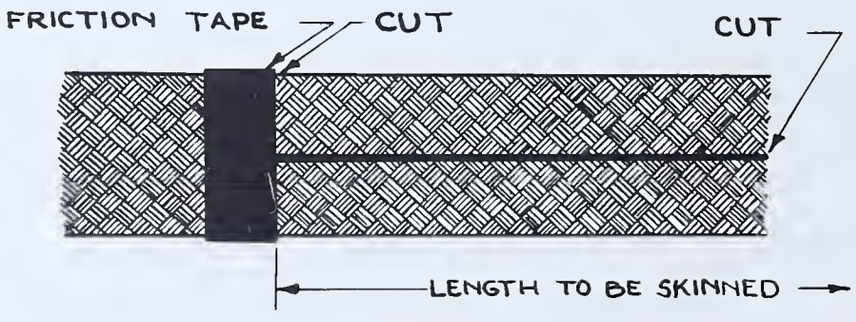


FIG. 1

3. Cut through all layers of insulation, at a point $\frac{1}{4}$" from the tape, until all conductors are exposed. See Fig. 2.

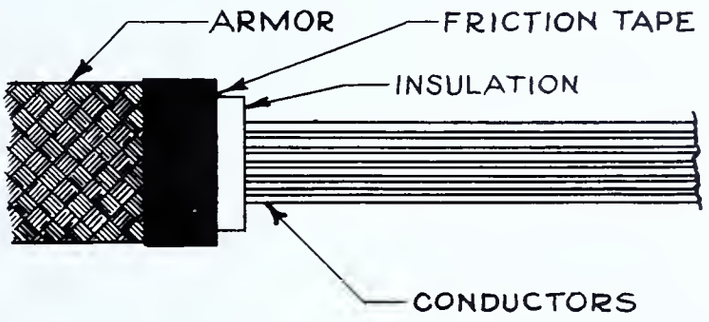


FIG. 2

4. Apply a coat of Glyptol over the tape and insulation at the exposed conductors, for moisture proofing and insulation protection.

To Lace a Cable

AFTER cable has been skinned, taped, and installed in the enclosed equipment, the conductors are to be laced.

1. Lace the conductors of the multi-conductor cables as specified on Sheet 3 of Unit 8. The finished job should have the appearance of Fig. 3.

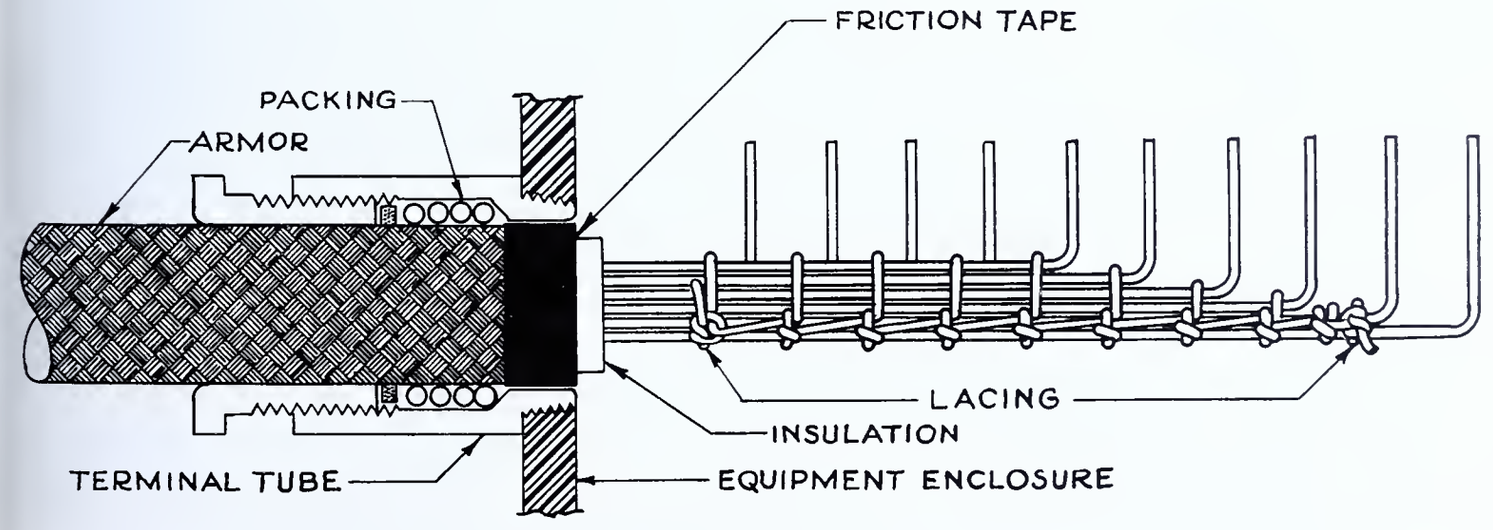


FIG. 3

2. Tape and serve the conductors of a lighting and power cable as specified on Sheets 2 and 3 of Unit 9.

   Apply a coat of Glyptol over the serving and over the tape on the conductors, for moisture proofing and insulation protection.

   The finished job should have the appearance of Fig. 4.

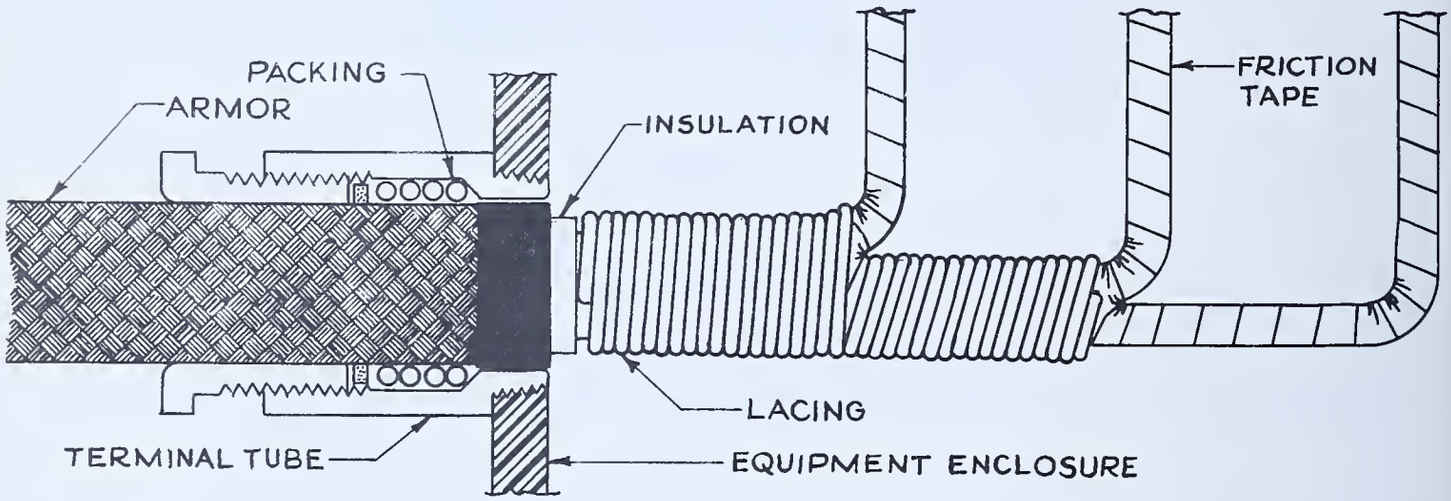


FIG.4

QUESTIONS

Place the answers to these questions in your notebook or on form as directed by instructor.

1. Outline the steps for removing the armor and insulation from the end of the cable.

2. Where is Glyptol applied to this type of cable end?

3. In this type of installation, after cable is taped and skinned, what step is necessary before conductors may be fanned and served?

4. Outline the steps of fanning and serving the conductors.

PART IV

INSTALLING AND PACKING CABLE FITTINGS

UNIT 11 — HOW TO SELECT AND INSTALL TERMINAL TUBES Page 52

UNIT 12 — HOW TO SELECT AND INSTALL STUFFING TUBES Page 61

A. To Select the Proper Type and Size of Stuffing Tubes Page 62

B. To Install Stuffing Tubes in Various Types of Bulkheads Page 63

C. To Install Stuffing Tubes in Various Types of Decks Page 73

Table I — Stuffing Tubes Page 76

Table II — Application of Stuffing Tubes (Steel) Page 78

Table III — Application of Stuffing Tubes (Aluminum) Page 80

Table IV — Application of Stuffing Tubes (Brass) Page 81

UNIT 13 — HOW TO PACK A TERMINAL TUBE AND A STUFFING TUBE Page 83

UNIT 14 — HOW TO SELECT AND INSTALL CABLE CLAMPS Page 86

UNIT 15 — HOW TO SELECT AND INSTALL A BUSHING Page 95

UNIT 16 — THE "60-40" RULE FOR INSTALLING GROUPS OF STUFFING TUBES AND BUSHINGS Page 101

HOW TO SELECT AND INSTALL TERMINAL TUBES

General Information:

Terminal tubes are installed in branch boxes, distribution boxes, junction boxes, lighting fixtures and appliances, and power equipments that are designed for watertight, gastight, or fumetight purposes, in order to preserve their designed purpose and to hold the cable in position.

Figures 1, 2 and 3 represent Navy types of terminal tubes used in cast metallic enclosures and are derived from U. S. Navy Bureau of Ships drawings 9-S-5010-L (for straight tubes), 9-S-5110-L (for 90° tubes) and 9-S-5111-L (for 45° tubes). Cast metallic boxes are provided with extra thicknesses of metal called "bosses" on the sides, to accommodate the installation of these types of terminal tubes.

Conservation of certain metals has prompted the Bureau of Ships to approve the substitution of steel for aluminum and brass terminal tubes, provided the component parts of the steel terminal tubes are zinc plated to insure suitable protection against corrosion.

Recent developments are rapidly changing the enclosing cases of fixtures, fittings and appliances from cast metal to sheet metal; hence new types of terminal tubes have been designed. Figures 6 and 7 represent new types of straight terminal tubes and are derived from the Bureau of Ships drawing 9-S-5235-L. Similar designs have been developed for 45° terminal tubes and 90° terminal tubes (Bureau of Ships drawings 9-S-5342-L and 9-S-5343-L, respectively).

Table I is used in conjunction with Navy Type cables and is derived from the above listed U. S. Navy Bureau of Ships drawings.

Tools:

- Center punch
- Hammer
- Drills (various sizes)
- Steel wire brush
- Pipe wrench
- I.P.S. pipe taps (various sizes)
- 12" metal scale
- #2 chuck

Materials:

- W.T. equipment (1/8" and 1/4" sheet metal may be used to simulate the installation)
- Terminal tube, Type XXI, size P
- Terminal tube, Type LII, size P
- 1/16" silver alloy wire ring, 1-3/4" inside diameter
- Flux paste
- Petrolatum and zinc dust compound
- Plastic sealer electrical insulator
- Gasoline
- Waste rag

Equipment:

- Drill press
- Oxy-acetylene torch

TO SELECT THE PROPER TYPE AND SIZE TERMINAL TUBE:

1. Size of Terminal Tube (Refer to Table I)

On Table I, Page 58, find the standard size designation of the cable from Column 1. Follow across this line until the column for the type of cable to be used is reached. The terminal tube size is designated by the letter at this intersection.

Example: Find the terminal tube size for an MHFA-37 cable. In column 1, (Table I) find the line across to the MHFA cable column. At this intersection the letter "P" is noted. Therefore, "P" is the size of the terminal tube.

Note: Selection of terminal tubes in commercial installations is determined by measuring the outside diameter of the cable and using a tube having suitable clearance for that size cable.

2. Type of Terminal Tube

The type of terminal tube is determined by the material of the equipment as referred to in Notes 1, 2 and 3 of Table I, and by the type of installation, as follows:

a. Cable that does not require a sharp bend upon entering equipment, uses a straight terminal tube. See Fig. 1.

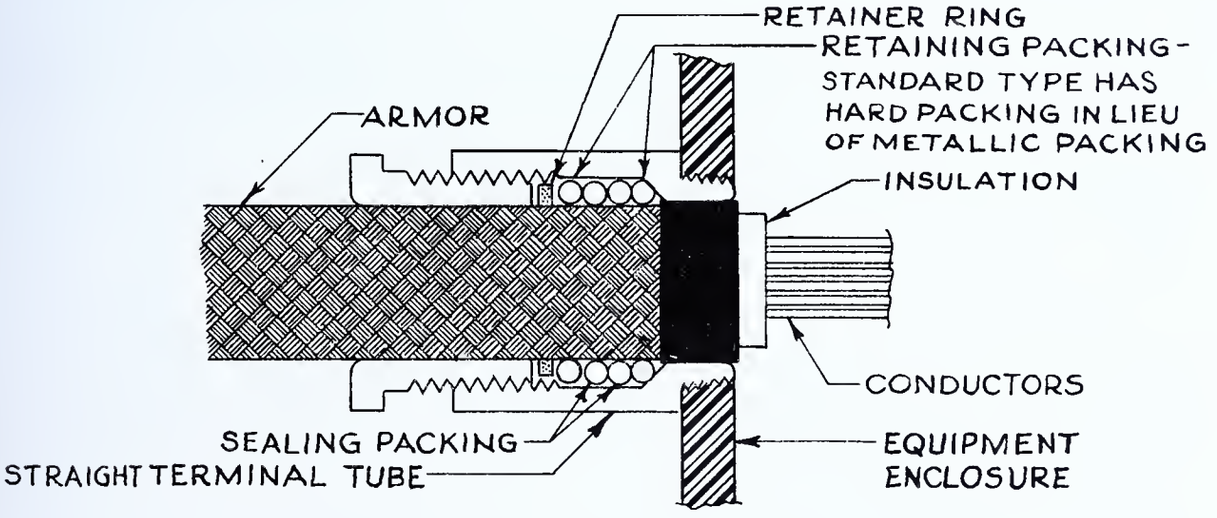


FIG. 1

Note: This is the standard type tube and is frequently the only type applied in commercial shipyards. There it may serve also as a "stuffing tube".

b. Cable that does not require a sharp bend but requires a bend of less than the minimum bending radius of the cable upon entering equipment, uses a 45° terminal tube. See Fig. 2.

c. Cable that requires a sharp bend upon entering equipment uses a 90° terminal tube. See Fig. 3.

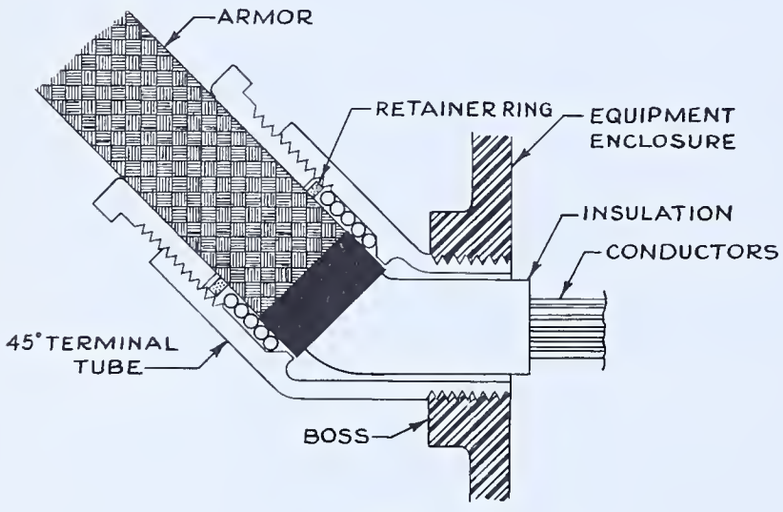


FIG. 2

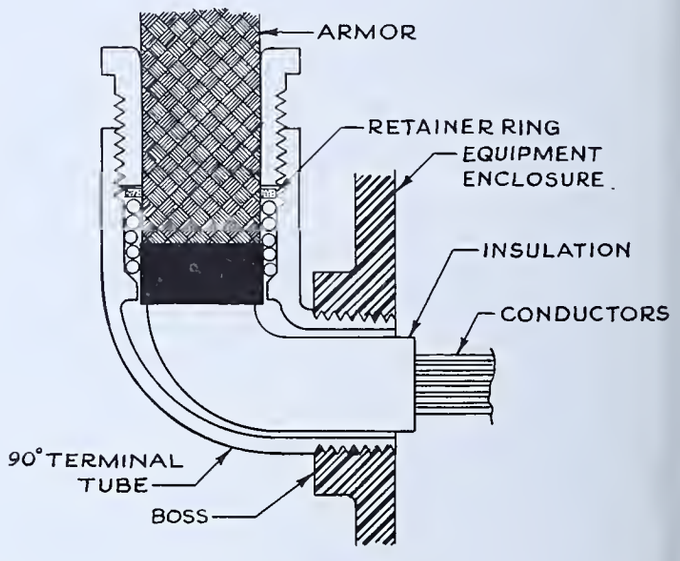


FIG. 3

Examples:

1. Determine the type terminal tube to be used in a cast aluminum alloy watertight connection box that is mounted on pads on a bulkhead. Cable layout is such that a sharp bend is not required.

   From the type of installation, a straight tube is to be used, and from Note 1 on Table I, an aluminum tube is required.

   From the Title Block, a straight aluminum terminal tube is Type XXI.

2. Determine the type terminal tube to be used in a cast aluminum alloy watertight connection box, mounted on a U bracket of a bulkhead. Cable layout is such that a sharp bend is required.

   From the type of installation, 90° tube is to be used, and from Note 1 on Table I, an aluminum tube is required.

   From the Title Block, a 90° aluminum tube is Type XLVII.

Figures 4 and 5 represent straight terminal tubes for use in sheet metal enclosures. 45° and 90° terminal tubes of this type are constructed similar to Figs. 2 and 3, respectively, except that they are provided with a neck for brazing in position instead of I.P.S. threads.

TYPE L I
(MACHINED)
STRAIGHT TERMINAL TUBE

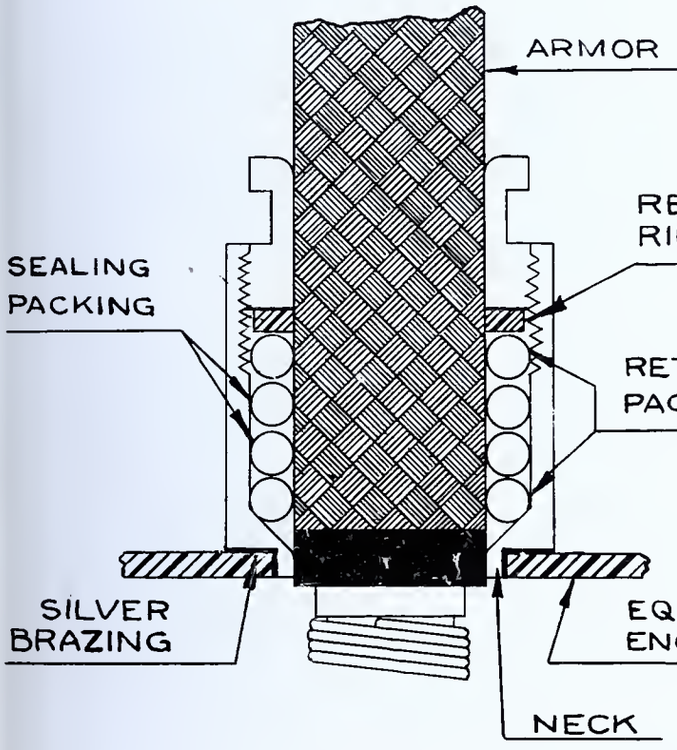


FIG. 4

TYPE L II
(DRAWN)
STRAIGHT TERMINAL TUBE

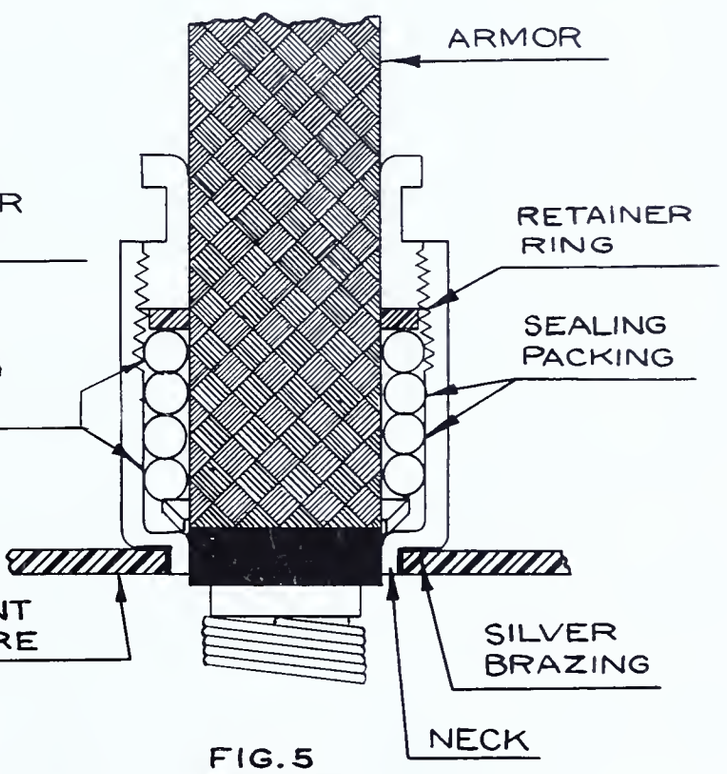


FIG. 5

TO INSTALL TYPES XXI, XXII, XLVII OR XLVIII TERMINAL TUBES:

1. Determine the size of the terminal tube from Table I.

2. Determine the "outside diameter of the body" from Table I for the particular size tube to be used. This information permits the spotting of the tube on the "boss" of the equipment.

3. Determine the location for the tube, then mark and punch the center location on the "boss".

4. Determine the size of the hole to be drilled from the "Drill Size for I.P.S. Taps" column on Table I, and drill hole through "boss".

5. Tap hole with I.P.S. tap of the size designated in the "I.P.S. Thread" column on Table I. The hole should be tapped for a tight fit but should permit the complete insertion of the threaded portion of the terminal tube.

   Note: The electrician should be particular to note that the outside diameter of thread does not exceed nor approach too closely the edge of the "boss", thereby weakening the "boss" structure.

6. Paint threads of terminal tube with petrolatum and zinc dust compound, and secure in the tapped hole in the equipment. Tighten tube with a pipe wrench.

   Note: Petrolatum and zinc dust compound is used on all aluminum threads to prevent seizing after assembly.

   To complete any installation of terminal tubes, cable is inserted and the tube is packed as outlined in Unit 13.

TO INSTALL TYPES LI, LII, LIII OR LIV TERMINAL TUBES:

1. Determine the size of the terminal tube from Table I.

2. Determine the "outside diameter of the body" from Table I for the particular size tube to be used. This information permits the spotting of the tube on the sheet metal enclosure.

3. Determine the location for the tube, then mark and punch the center location on the sheet metal enclosure.

4. Determine the size of the hole to be drilled from the "drill size" column of Table I and drill hole through the enclosure.

5. Clean the zinc chromate primer from the neck and bottom of the tube, using a steel wire brush.

6. Remove paint or scale from around the hole in the enclosure, using a steel wire brush.

7. Wash the faying surfaces (Steps 5 and 6) with gasoline and waste rag.

8. Paint the neck of the tube and the area around the hole in the enclosure with flux paste.

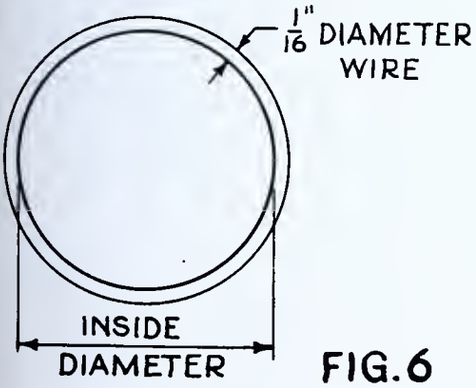


FIG.6

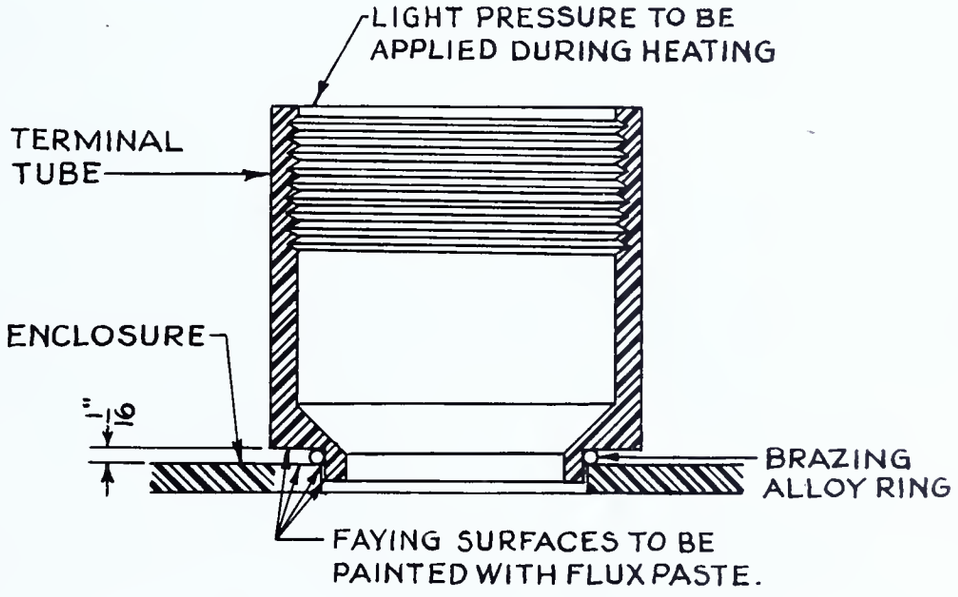


FIG.7

9. Determine size of brazing ring (see Fig. 6) for the particular tube to be used from "silver alloy ring" column on Table I.

10. Obtain brazing ring from stock and install over the neck of the terminal tube and insert terminal tube in the hole in the enclosure. See Fig. 7.

11. Heat the terminal tube uniformly by means of an oxy-acetylene torch until the ring melts and fillets around the terminal tube between the terminal tube and the enclosure.

Note: The weight of the tube gives sufficient pressure on a horizontal surface but a light pressure must be applied when the tube is inserted in the side or underside of the enclosure.

12. Remove flux from the terminal tube and enclosure, by application of water or a wet rag to the hot terminal tube and enclosure.

To complete any installation of terminal tubes, cable is inserted and the tube is packed as outlined in Unit 13.

TABLE I

STANDARD SIZE DESIGNATION	ACTUAL C. M. AREA	TYPE CABLE																								
		SLPP	SLPA	DLPP	DLPA	TLPP	TLPA	SFPP	SFPA	DFPP	DFPA	TFPP	TFPA	FFPP	FFPA	SHFA	DHFA	THFA	FHFA	FLP	FLA	SRLL	SRHLA	DRHLA	DRLL	TRHLA
3	2828	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	C	C	C	-	-	-	-	-	-	-
4	4494	A	A	D	D	D	E	A	B	D	E	E	F	F	G	B	E	F	G	G	G	A	K	T	C	V
9	9030	C	C	G	J	J	J	B	C	E	G	F	G	-	-	D	G	G	-	-	-	-	-	-	-	-
14	14350	C	D	J	J	J	K	C	C	G	G	G	J	-	-	D	G	J	-	-	-	-	-	-	-	-
23	22820	D	D	K	K	K	K	C	D	G	J	J	K	-	-	D	J	K	-	-	-	-	-	-	-	-
30	30780	D	E	L	L	L	L	C	D	J	K	K	L	-	-	E	K	L	-	-	-	-	-	-	-	-
40	38950	E	E	L	L	M	M	C	D	K	L	L	L	-	-	E	L	L	-	-	-	-	-	-	-	-
50	49020	E	F	M	M	M	M	D	D	L	L	L	M	-	-	F	L	M	-	-	-	-	-	-	-	-
60	59940	F	F	M	M	N	N	D	E	M	M	M	N	-	-	G	M	N	-	-	-	-	-	-	-	-
75	75850	G	G	N	N	P	P	D	E	N	N	P	P	-	-	G	N	P	-	-	-	-	-	-	-	-
100	98820	G	G	P	P	R	R	E	F	P	P	R	R	-	-	G	P	R	-	-	-	-	-	-	-	-
125	125050	J	J	R	R	S	S	E	G	R	R	R	S	-	-	J	R	S	-	-	-	-	-	-	-	-
150	157380	J	J	S	S	T	T	G	G	S	S	T	T	-	-	J	S	T	-	-	-	-	-	-	-	-
200	198860	K	K	T	T	T	V	G	J	T	T	T	V	-	-	K	T	V	-	-	-	-	-	-	-	-
250	250710	L	L	V	V	W	W	-	-	V	V	W	X	-	-	-	V	X	-	-	-	-	-	-	-	-
300	296660	L	M	W	W	X	X	J	K	W	X	X	X	-	-	L	X	X	-	-	-	-	-	-	-	-
400	414020	M	M	Y	Y	Z	Z	K	L	Y	Y	Z	Z	-	-	M	Y	Z	-	-	-	-	-	-	-	-
500	521970	N	N	-	-	-	-	L	M	-	-	-	-	-	-	N	-	-	-	-	-	-	-	-	-	-
650	657860	P	P	-	-	-	-	M	N	-	-	-	-	-	-	N	-	-	-	-	-	-	-	-	-	-
800	829310	R	R	-	-	-	-	N	P	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-
1000	1046000	S	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1500	1662000	V	V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(continued on page 59)

TABLE I (continued)

STANDARD SIZE DESIGNATION	NUMBER OF CONDUCTORS OR PAIRS	TYPE CABLE										
		GICD	GICA	GICF	MFPP	MFPA	MHFA	MCP	TPTP	TPTA	TTHFA	MCMB
1	1	-	-	-	-	-	-	-	-	A	B	-
2	2	C	C	B	D	D	C	-	-	-	-	-
3	3	-	-	-	-	-	-	-	B	B	C	-
4	4	E	E	-	D	E	E	B	-	-	-	-
5	5	-	-	-	-	-	-	C	D	D	C	-
7	7	G	G	C	E	G	G	C	-	-	-	D
10	10	J	J	E	J	J	J	D	E	E	D	-
12	12	-	-	-	-	-	-	D	-	-	-	-
14	14	K	K	J	K	K	K	-	-	-	-	-
15	15	-	-	-	-	-	-	-	F	F	E	-
19	19	L	L	M	K	L	L	-	-	-	-	-
20	20	-	-	-	-	-	-	-	G	G	F	-
22	22	M	M	N	M	M	M	-	-	-	-	-
25	25	-	-	-	-	-	-	-	G	G	G	-
26	26	M	M	N	M	N	N	-	-	-	-	-
30	30	N	N	P	N	N	N	-	G	J	G	-
37	37	N	N	P	P	P	P	-	-	-	-	-
40	40	-	-	-	-	-	-	-	J	J	J	-
44	44	P	P	R	R	S	S	-	-	-	-	-
50	50	-	-	-	-	-	-	-	K	K	J	-
60	60	-	-	-	-	-	-	-	K	K	L	-

STANDARD SIZE DESIGNATION	TYPE CABLE		
	SCP	DCP	TCP
1	-	A	A
1-1/2	-	A	-
2	-	A	A
2-1/2	-	-	-
3	-	B	A
4	-	B	B
6	-	C	C
8	-	-	-
9	-	C	C
13	-	-	-
14	-	G	-
21	-	-	-
23	-	K	-
30	-	L	-
40	-	-	M
150	-	-	S
250	-	-	W
400	-	-	Z
650	-	-	-
800	T	-	-

FOR USE WITH TYPES XXI, XXII, XLVII, AND XLVIII TUBES				
SIZE TERMINAL TUBE	DIAMETER HOLE FOR CABLE	OUTSIDE DIAMETER OF BODY	I. P. S. THREAD	DRILL SIZE FOR I. P. S. TAP
	Inches	Inches	Inches	Inches
A	0.406	1- 1/8	3/8	9/16
B	0.515	1- 1/4	1/2	45/64
C	0.640	1- 3/8	3/4	29/32
D	0.750	1- 1/2	3/4	29/32
E	0.812	1- 1/2	3/4	29/32
F	0.843	1- 9/16	1	1- 9/64
G	0.953	1-13/16	1	1- 9/64
J	1.062	1-15/16	1-1/4	1-31/64
K	1.171	2- 1/16	1-1/4	1-31/64
L	1.265	2- 1/8	1-1/4	1-31/64
M	1.406	2- 3/8	1-1/2	1-23/32
N	1.515	2- 7/16	1-1/2	1-23/32
P	1.625	2- 9/16	2	2- 3/32
R	1.750	2-11/16	2	2- 3/32
S	1.875	3- 1/16	2	2- 3/32
T	2.062	3- 1/4	2-1/2	2- 5/8
V	2.187	3- 3/8	2-1/2	2- 5/8
W	2.312	3- 9/16	3	3- 1/4
X	2.500	3- 3/4	3	3- 1/4
Y	2.609	3- 7/8	3	3- 1/4
Z	2.750	4- 1/16	3-1/2	3-47/64

FOR USE WITH TYPES LI, LII, LIII AND LV TUBES

Size of Term. Tube	Dia. Hole for Cable (inches)	Outside Dia. of body (inches)	Outside Dia. of neck (inches)	Drill size (inches)	Silver Alloy Ring (Inside Dia.) (inches)
A	0.406	0.979	0.551	9/16	9/16
B	0.515	1.104	0.660	11/16	11/16
C	0.640	1.229	0.785	13/16	13/16
D	0.750	1.354	0.895	15/16	15/16
E	0.812	1.354	0.957	1	1
F	0.843	1.416	0.988	1	1
G	0.953	1.604	1.098	1- 1/8	1- 1/8
J	1.062	1.729	1.207	1- 1/4	1- 1/4
K	1.171	1.854	1.316	1- 3/8	1- 3/8
L	1.265	1.916	1.410	1- 7/16	1- 7/16
M	1.406	2.104	1.551	1- 9/16	1- 9/16
N	1.515	2.236	1.716	1- 3/4	1- 3/4
P	1.625	2.361	1.826	1- 7/8	1- 7/8
R	1.750	2.486	1.951	2	2
S	1.875	2.861	2.076	2- 1/8	2- 1/8
T	2.062	3.174	2.364	2- 3/8	2- 3/8
V	2.187	3.299	2.489	2- 1/2	2- 1/2
W	2.312	3.424	2.614	2-11/16	2-11/16
X	2.500	3.549	2.802	2-13/16	2-13/16
Y	2.609	3.674	2.911	2-15/16	2-15/16
Z	2.750	3.861	3.083	3- 1/8	3- 1/8

NOTES:

1. Aluminum Terminal Tubes are for use only with aluminum or steel appliances with cast enclosures or plates,
2. Brass Terminal Tubes are for use only with brass appliances with cast enclosure plates.
3. Steel Terminal Tubes are for use only with appliances with sheet metal enclosures.

APPLICATION OF TERMINAL TUBES
TYPE XXI (Alum.) Straight
TYPE XXII (Brass) Straight
TYPE XLVII (Alum.) 90°
TYPE XLVIII (Alum.) 45°
TYPE LI (Steel) (machined) straight
TYPE LII (Steel) (drawn) straight
TYPE XIII (Steel) (drawn) 45°
TYPE LV (Steel) (drawn) 90°

DATA FROM 9-S-5010-L, 9-S-5110-L,
9-S-5111-L, 9-S-5235-L,
9-S-5342-L, 9-S-5343-L

QUESTIONS

Place the answers to these questions in your notebook or on form as directed by instructor.

1. What is the purpose of a terminal tube?

2. What is a "boss"?

3. What information is necessary to spot a terminal tube on equipment?

4. What type of terminal tube is used for:

   (a) Cable not requiring a sharp bend upon entering equipment?

   (b) Cable not requiring a sharp bend but requiring a bend of less than the minimum bending radius of the cable upon entering equipment?

   (c) Cable requiring a sharp bend upon entering equipment?

5. What procedures are necessary to prepare a cast metal enclosure for insertion of terminal tube?

6. What procedures are necessary to prepare a sheet metal enclosure for insertion of a terminal tube?

7. (a) What compound is applied to all aluminum threads?

   (b) What is the purpose?

HOW TO SELECT AND INSTALL STUFFING TUBES

General Information:

Stuffing tubes are installed in watertight bulkheads and decks where cables penetrate, in order to keep them watertight, gastight, fumetight, and oiltight. On new construction, stuffing tubes are installed before insulation is in place on bulkheads and decks, and before wood covering is installed on weather decks.

When installing a stuffing tube in a deck or bulkhead, a minimum distance of 3" must be maintained between the tubes and the adjoining deck or bulkhead. See Fig. 1.

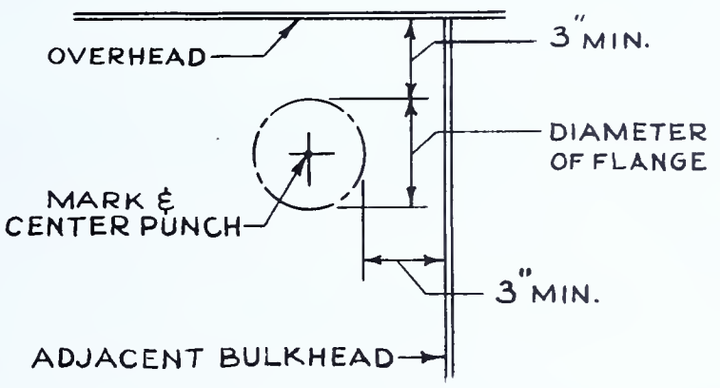


FIG. 1

Wherever more than one stuffing tube is installed (adjacent to each other) in decks and bulkheads, the "60-40" rule must be followed for spacing. For use of "60-40" rule refer to Unit 16.

TO SELECT THE PROPER TYPE AND SIZE OF STUFFING TUBES:

Notes: (a) Tables I, II, III and IV are used in conjunction with Navy type cables and are derived from U. S. Navy Bureau of Ships drawings 9-S-4680-L, 9-S-4950-L, 9-S-4681-L and 9-S-5166-L as indicated.

(b) Although Navy type designations are used herein, the methods given are typical for application to corresponding types in commercial installation.

1. Size of Stuffing Tube (Refer to Table I, Pages 76-77)

On Table I find the "standard size designation" of the cable from Column 1. Follow across this line until the column for the type of cable is reached. The stuffing tube size is designated by the letter at this intersection.

Example: Find the stuffing tube size for type DHFA-9 cable. In Column 1 find standard size designation 9. Follow this line across to the DHFA cable column. At this intersection the letter "G" is noted. Therefore, "G" is the size of the stuffing tube required.

Note: Selection of stuffing tubes in commercial installation is determined by measuring the outside diameter of the cable and selecting a tube having suitable clearance for that size cable.

2. Type of Stuffing Tube

Note: To determine the type and the material of a stuffing tube, the type and thickness of the deck or bulkhead must be known.

From the sketches on Tables II, III or IV, pages 78-81, locate the type and thickness of the bulkhead or deck and the type of stuffing tube as indicated

Examples: (a) Find the stuffing tube required for a steel bulkhead 3/4" thick. This type of bulkhead is indicated on Table II and the stuffing tube is Type XXX-1.

(b) Find the stuffing tube required for an aluminum deck 1/2" thick with 1" of insulation. This type of deck is indicated on Table III and the stuffing tube is Type XLV.

From the above, a DHFA-9 cable that is to penetrate a steel bulkhead 3/4" thick will require a Type XXX-1, size "G" stuffing tube.

Also, from the above, a DHFA-9 cable that is to penetrate an aluminum deck 1/2" thick with 1" of insulation, will require a Type XLV, size "G" stuffing tube.

Note: In commercial installations various combinations of standard pipe fittings, plus a stuffing tube for packing are customary.

O INSTALL STUFFING TUBES IN VARIOUS TYPES OF BULKHEADS:

Note: All threads are to be given a coat of petrolatum and zinc dust compound before assembly, to prevent seizing after assembly.

1. Determine size and type of cable to be used.

2. Ascertain the size of the stuffing tube from Table I, Pages 76-77.

3. Determine the "outside diameter of the flange" or "outside diameter of the tube" from Table II or "largest outside diameter" from Tables III or IV, for the particular type tube.

4. Determine the location for the tube, mark and punch the center location of the bulkhead.

5. Determine the size of the hole to be drilled in the bulkhead for the stuffing tube from the "diameter hole for cable", "outside diameter of I.P.S. pipe" or "outside diameter of body" column on Table II or "diameter hole required for tube" column on Tables III or IV, depending upon the type of stuffing tube used.

   Example: Stuffing tube required at a 3/4" steel bulkhead for a DHFA-9 cable is Type XXX-1 (Table II), size G (Table I). Hole to be drilled in the bulkhead is 2" in diameter.

6. Have the bulkhead drilled by a driller.

Tools:

End wrench
Knife
6' folding rule
Center punch
Hammer, ball-peen
Rat-tail file
Hand shears
Screw driver
Pipe wrench
Mandrel (size to suit job)
12" metal rule
12" hack saw
Scribe

Associated Trades:

Driller
Shipwright
Shipfitter
Welder
Sheet metal worker

Materials:

Red lead paste
Petrolatum and zinc dust compound
Raw linseed oil
Sheet asbestos
Phenolic varnish
Galvanized steel pipe (I.P.S)
(size and length to suit)
Stuffing tubes (various types and sizes)
Round head machine screws, steel
(size and length to suit job)
Metal washers (size to suit job)
Heavy canvas (#10)
Graphite
Vaseline
Spar varnish
Canton flannel

Equipment:

Pipe vise
Pipe stock and dies
(size to suit job)
Power hack saw

7A. For Type XXX-1, stuffing tubes which are used for decks and bulkheads (without insulation) 3/4" thickness and under.

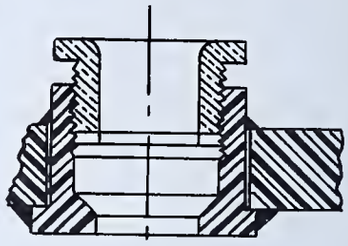


FIG. 2

1. Mark and drill hole for stuffing tube. See Page 63.

2. Insert the body of the tube into the drilled hole in the bulkhead until the flange butts the bulkhead. See Fig. 2.

   Note: Where WT and NWT compartments are adjacent to each other, the packing end of a bulkhead tube is installed in the tight compartment.

3. Apply graphite and vaseline to the threads and insert the gland nut of the stuffing tube in position so that in the welding process the tube body will not warp. This is a necessary precaution whenever welding any stuffing tube.

4. Hold tube in position with a piece of steel or wood and have a welder "tack" weld the flange to bulkhead.

5. Have welder complete "fillet" weld all around the edge of the flange and body of tube as shown in Fig. 2.

7B. For Type XXX-1A stuffing tube.

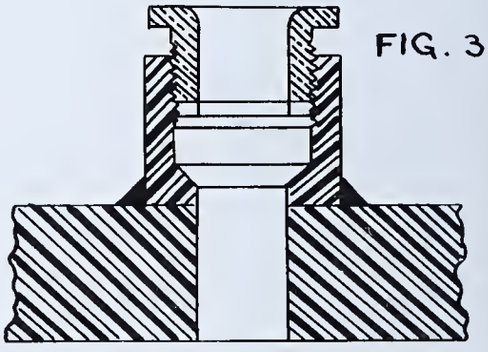


FIG. 3

1. Mark and drill hole for tube.

2. Insert a mandrel, the size of cable, through stuffing tube and hole in bulkhead.

3. Apply graphite and vaseline to the threads and insert the gland nut of the stuffing tube in position.

4. Hold tube flush against bulkhead and have welder "tack" weld body of the tube to the bulkhead.

5. Remove mandrel and have welder fillet weld body all around. See Fig. 3.

7C. For Types XLIX-1, XLIX-2 and XLIX-3, stuffing tubes.

XLIX-1 Bulkheads with insulation - one side (refrigerating space)
XLIX-2 Bulkheads with insulation - one side (refrigerating space)
XLIX-3 Bulkheads with insulation including air casing with insulation

1. Mark and drill hole for stuffing tube.

2. Ascertain the thickness of the bulkhead (including insulation).

3. Select a piece of galvanized steel pipe (I.P.S.) to suit the size tube to be installed and of sufficient length to suit the dimension obtained in Step 2 plus 1-3/4" after being inserted into the stuffing tube. See Fig. 4.

   Note: The 1-3/4" is to allow 1" between the bottom of the tube and the bulkhead and 3/4" of pipe beyond the bulkhead on the side opposite the tube.

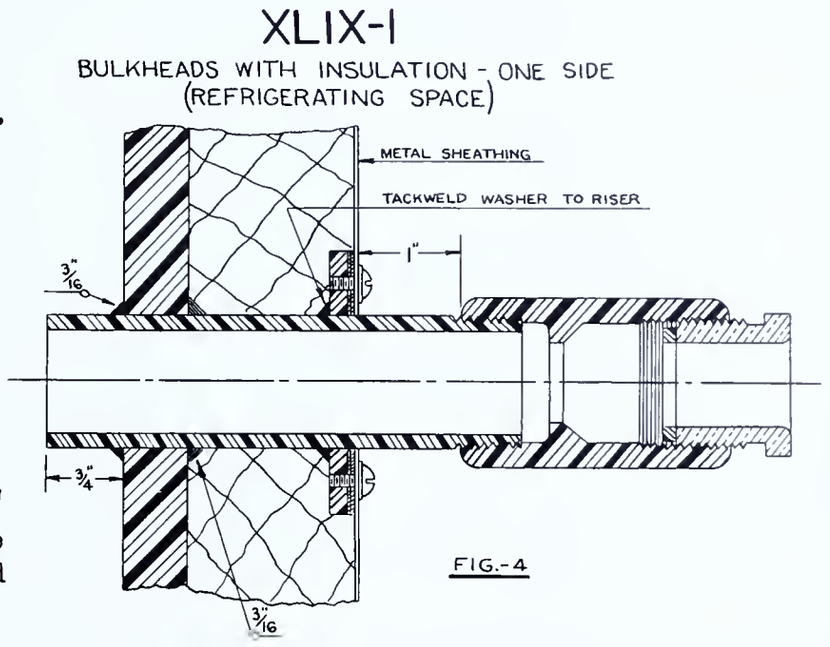


FIG.-4

4. Thread one end of the pipe and insert into stuffing tube.

5. Secure pipe in a pipe vise and tighten tube on pipe, using a pipe wrench.

6. Measure length of pipe required (Step 3) and cut off the excess pipe.

7. Remove sharp edges from inside of pipe, using a rat-tail file.

8. Cut an asbestos washer (1/32" thick) using a metal washer as a template (see Fig. 4).

9. Install asbestos washer, then the metal washer over pipe and have welder "tack" weld metal washer to the pipe at a distance of 1-1/8" from the bottom of the stuffing tube (see Table III).

   Note: The 1-1/8" is to allow a 1" clearance between the bulkhead and the stuffing tube, 1/32" for the asbestos washer and 3/32" for thickness of sheathing over the insulation.

10. Ascertain the thickness of the insulation (less sheathing).

11. Subtract 5/32" from the distance obtained in Step 10 and measure this distance from the bottom of the metal washer (Step 9). Scribe a line at this point.

    Note: The 1/32" is subtracted to allow for the thickness of the asbestos washer (1/32") and the metal washer (1/8").

12. Insert the pipe in the drilled hole in the bulkhead until the scribed line (Step 11) is even with the steel bulkhead.

13. Hold pipe in a level position and have welder "tack" weld pipe to the bulkhead.

14. Have welder "fillet" weld pipe (all around) to both sides of the steel bulkhead as shown in Table III.

    Note: Where bulkhead is insulated on both sides, add Steps 15-18. Otherwise, go directly to Step 19.

15. Ascertain the thickness of the insulation (less sheathing) on the open end of the tube.

16. Subtract 1/32" from the distance obtained in Step 15 and measure this distance from the steel bulkhead. Scribe a line at this point.

    Note: The 1/32" is subtracted to allow for the thickness of an asbestos washer.

17. Install a metal washer over the pipe and line up the outer edge of the washer with the scribed line (Step 16). Have welder "tack" weld the inner side of the washer to the pipe.

18. Cut an asbestos washer (1/32" thick) using the metal washer (Step 17) as a template.

19. After insulation is in place, have sheet metal worker template and drill holes in the sheathing to suit the metal washers (Steps 9 and 17).

20. Secure asbestos washers to steel washers, using spar varnish.

21. After sheathing is in place, fasten sheathing to metal washers using round head machine screws fitted with flat washers. See Fig. 4.

7D. For Type XLIX-4 stuffing tubes, for partition bulkheads (refrigerating space)

1. Locate and drill hole for stuffing tube.

2. Determine thickness of bulkhead (including sheathing).

3. Select a piece of galvanized steel pipe (I.P.S.) to suit the size tube to be installed and of sufficent length to suit the dimension obtained in Step 7 plus 1-3/4" after being inserted into the stuffing tube. See Fig. 5.

   Note: The 1-3/4" is to allow 1" between the bottom of the tube and the bulkhead and 3/4" of pipe beyond the bulkhead on the side opposite the tube.

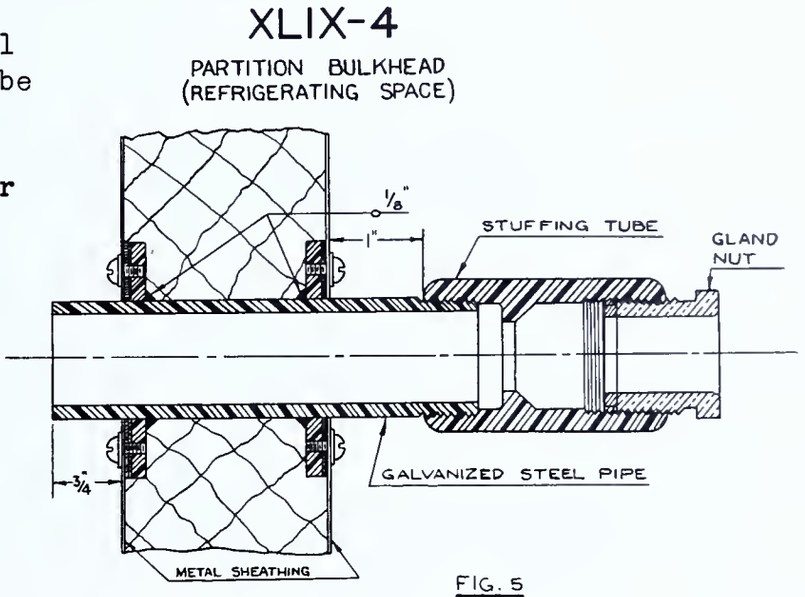


FIG. 5

4. Thread one end of pipe and insert into stuffing tube.

5. Secure pipe in a pipe vise and tighten tube on pipe, using a pipe wrench.

6. Measure length of the pipe required (Step 3) and cut off the excess pipe.

7. Remove sharp edges from inside of pipe, using a rat-tail file.

8. Cut two asbestos washers (1/32" thick) using a metal washer as a template. See Fig. 5.

9. Install asbestos washer, then the metal washer over pipe and have welder "tack" weld metal washer to the pipe at a distance of 1-1/8" from the bottom of the stuffing tube. See Fig. 5.

   Note: The 1-1/8" is to allow a 1" clearance between the bulkhead and the stuffing tube, 1/32" for the asbestos washer and 3/32" for thickness of sheathing over the insulation.

10. Determine the thickness of the insulation (less sheathing).

11. Subtract 3/16" from the distance obtained in Step 10 and measure this distance from the bottom of the metal washer (Step 9). Scribe a line at this point.

    Note: The 3/16" is subtracted to allow for thicknesses of one metal washer (1/8") and two asbestos washers (1/32").

12. Have sheet metal worker template and drill holes in sheathing to suit metal and asbestos washer on the pipe.

13. Secure asbestos washer to steel washer (Step 9) using spar varnish.

14. Secure metal washer (Step 9) to sheathing, using round head machine screws fitted with flat washers. See Fig. 5.

15. Install a metal washer over the pipe and line up the outer edge of the washer with the scribed line (Step 11). Have welder "tack" weld inner edge of washer to the pipe.

16. After insulation is in place, have sheet metal worker template and drill holes in the sheathing to suit the metal washer.

17. Install asbestos washer (Step 8) over the pipe and secure to the metal washer (Step 15), using spar varnish.

18. After sheathing is in place, fasten sheathing to metal washers using round head machine screws fitted with flat washers. See Fig. 5.

7E. For Type XLVII-1 stuffing tubes, for decks or bulkheads over 3/4" with or without insulation

1. Locate and drill hole for tube.

2. Determine the thickness of the bulkhead (including insulation).

3. Select a piece of galvanized steel pipe (I.P.S.) to suit the tube to be installed and of sufficient length to suit the dimension obtained in Step 7 plus 3/4" after being inserted into the stuffing tube. See Fig. 6.

   Note: The 3/4" is to allow the pipe to extend 3/4" beyond the insulated side of the bulkhead.

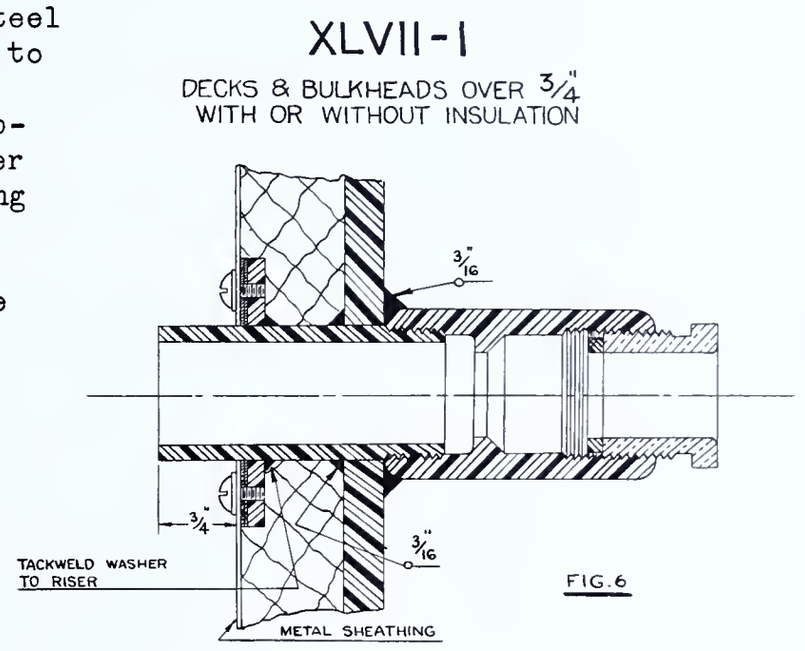


FIG. 6

4. Thread one end of the pipe and insert into stuffing tube.

5. Secure pipe in a pipe vise and tighten tube on pipe, using a pipe wrench.

6. Measure length of pipe required (Step 3) and cut off the excess pipe.

7. Remove sharp edges from inside of pipe using a rat-tail file.

8. Insert the pipe in the drilled hole in bulkhead until the tube butts the bulkhead. See Fig. 6.

9. Hold tube in position with a piece of steel or wood and have a welder tack weld the tube to bulkhead.

10. Have welder complete fillet-weld all around the edge of the tube and the pipe as shown in Fig. 6.

11. Determine the thickness of the insulation (less sheathing).

12. Subtract 1/32" from the distance obtained in Step 11, and measure this distance from the bulkhead toward the end of the pipe. Scribe a line at this point.

    Note: The 1/32" is subtracted to allow for the thickness of the asbestos washer.

13. Install a metal washer over the pipe and line up the outer edge of the washer with the scribed line (Step 12). Have welder tack-weld inner edge of washer to the pipe.

14. After insulation is in place, have sheet metal worker template and drill holes in the sheathing to suit the metal washer (Step 13).

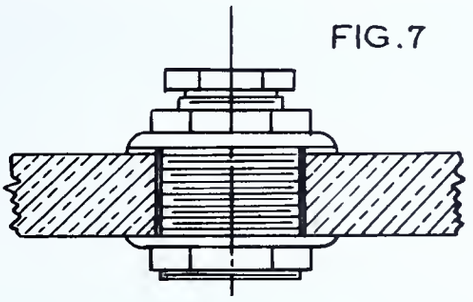
15. Cut an asbestos washer (1/32" thick) using the metal washer (Step 13) as a template.

16. Install asbestos washer over the pipe and secure to the metal washer, using spar varnish.

17. After sheathing is in place, fasten sheathing to metal washers, using round head machine screws fitted with flat washers. See Fig. 6.

7F. For Types XXXV, XLII and XLIV stuffing tubes

FIG.7



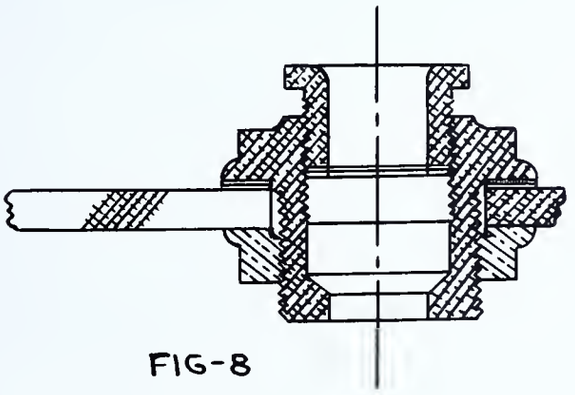


FIG-8

1. Locate and drill hole for tube.

2. Make canvas washers (cut with knife or scissors), if not available in stock.

3. Soak washers in raw linseed oil and allow to dry.

4. Paint washers with heavy red lead.

5. Place washers next to bulkhead on packing side of tube and insert body of tube through drilled hole.

6. Install and tighten lock nut with an end wrench. See Figs. 7 and 8.

Note: Type XLIV tube is similar to Type XLII.

7G. For Type XXXVII stuffing tube, for brass decks and bulkheads with insulation up to two inches over-all.

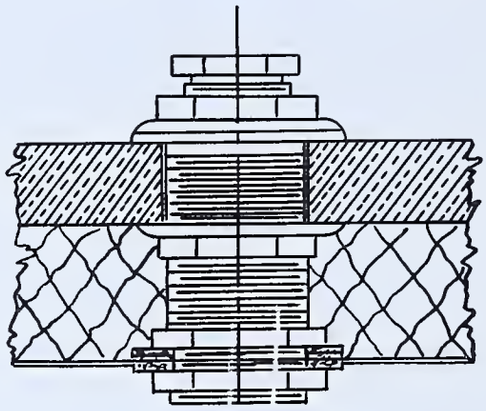


FIG. 9

1. Locate and drill hole for tube.
2. Install spacer nut to suit thickness of insulation. See Fig. 9.
3. Make asbestos washer if not in stock.
4. Impregnate washer in phenolic varnish and allow it to dry.
5. Install asbestos washer, metal washers and lock nut (Fig. 9) during installation of sheathing, after insulation is in place.
6. Tighten lock nut with end wrench.

TO INSTALL STUFFING TUBES IN VARIOUS TYPES OF DECKS

General Information:

When a cable penetrates a deck, a pipe riser that will extend not less than 14" above the deck is installed to prevent the accidental shearing or damaging of the cable at the deck level. These risers are commonly referred to as "kick-pipes" and are equipped with a stuffing tube on the upper end (illustrated on Tables II, III and IV). See Fig. 10.

The kind and type of risers for all types of decks are determined from Notes 3 to 6 of Table II.

Note: Where a kickpipe is used, the packing or "gland" nut is removed from the deck stuffing tube to permit the installation of the kickpipe in the stuffing tube.

1. The installation of stuffing tubes through decks follows similar procedures as the stuffing tubes through bulkheads, with the exception of Type XLVIII-4 stuffing tube. Similar deck and bulkhead tubes are as follows:

   (a) For steel decks (including weather decks) with or without insulation Types XLVIII-1 and XLVIII-2 correspond to Type XLVII-1. The noted difference is that the riser pipe instead of the stuffing tube is welded to the deck.

   (b) For steel decks (including air casings) with insulation Type XLIX-3 corresponds to Type XLVIII-3.

   (c) For steel armored decks without insulation Type XLVIII-1A corresponds to Type XXX-1A.

   (d) For brass decks without insulation Type XXXVI corresponds to Type XXXV.

   (e) For brass decks with and without insulation Type XXXVIII corresponds to Type XXXVII.

   (f) For aluminum decks without insulation Type XLIII corresponds to Type XLII.

   (g) For aluminum decks with and without insulation Type XLV corresponds to Type XLIV.

XLVIII-1

DECKS WITH OR WITHOUT INSULATION
(INCLUDING WEATHER DECKS AND REFRIGERATING SPACES)

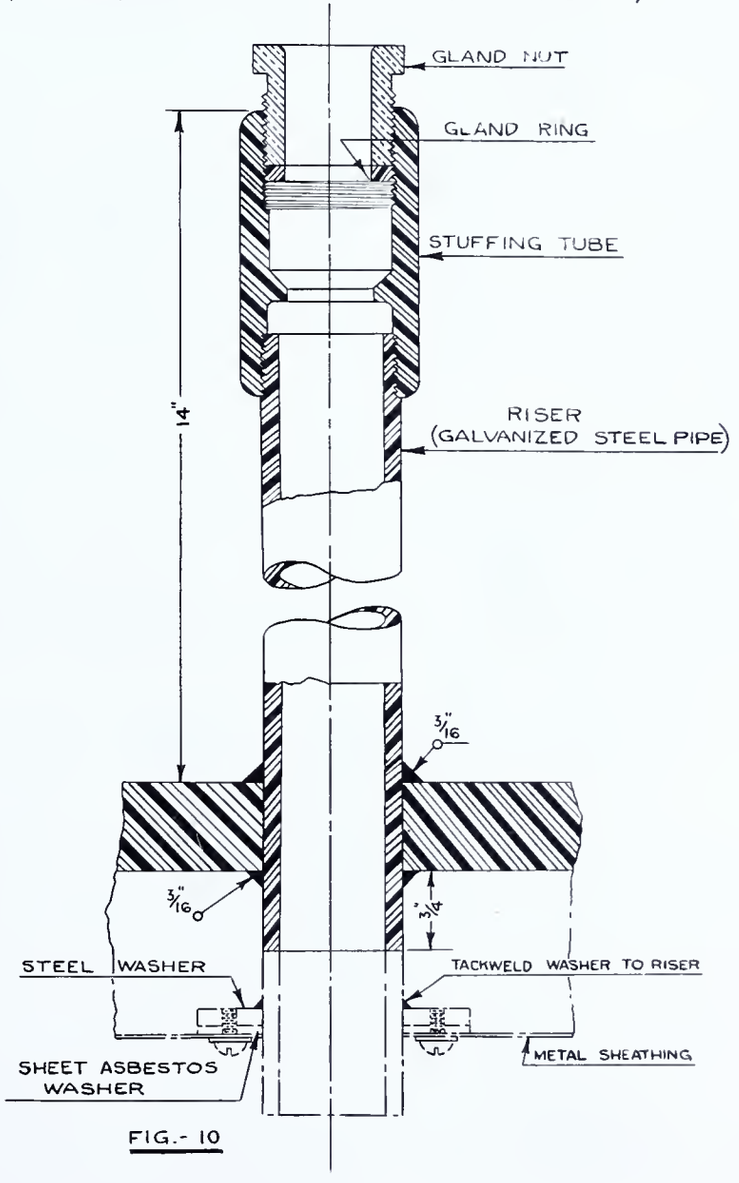


FIG.- 10

(h) For Type XLVIII-4 stuffing tubes, steel decks with top insulation.

After the size and type of cable and location of tube have been determined and the deck drilled for the correct size of pipe (as outlined for bulkhead tubes) the following steps are to be followed.

1. Determine the thickness of the deck (including insulation and sheathing).

2. Select a piece of galvanized steel pipe (I.P.S.) to suit the size tube to be installed and to give a length of 15" plus the dimension obtained in Step 1 from the top of the tube to the bottom of the pipe after assembly. See Fig. 11.

   Note: The 15" is to allow 1" at the bottom of the pipe for installation of locknut, canvas or canton washer and slip ring and to allow 14" above the deck to the top of the stuffing tube.

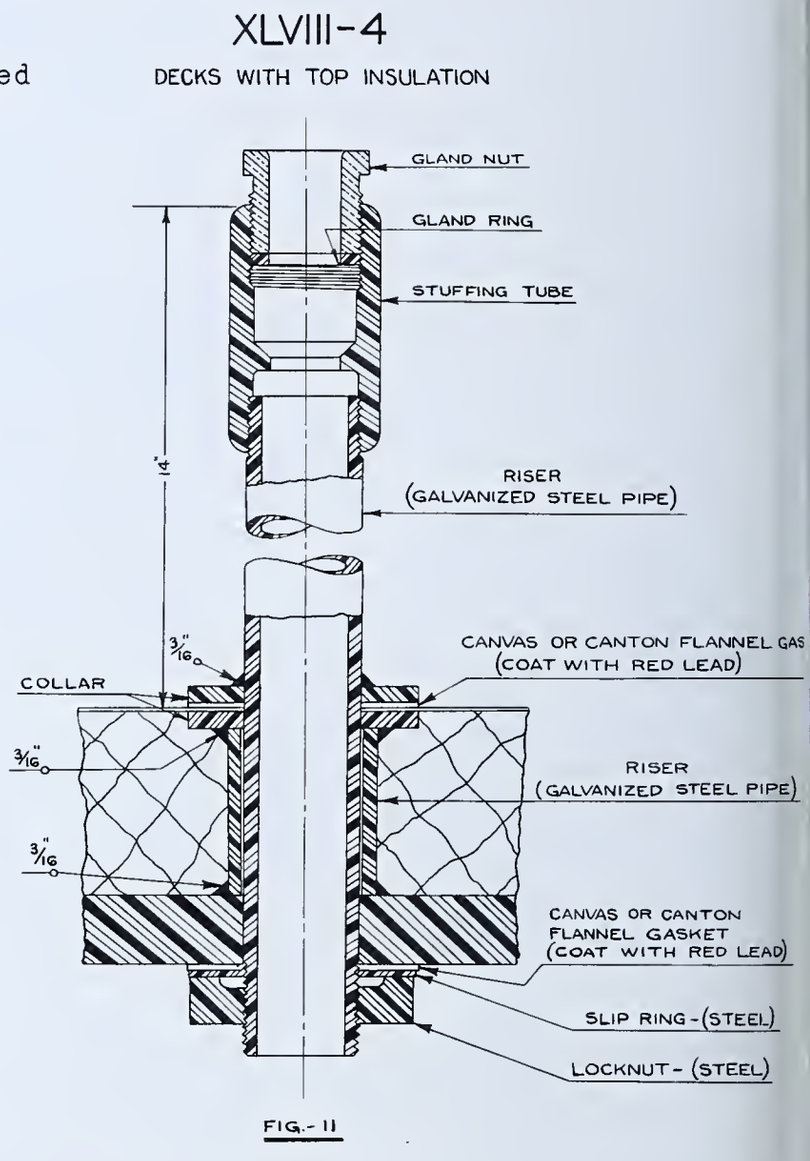


FIG.-11

3. Thread one end of the pipe for sufficient length and insert into stuffing tube.

4. Secure pipe in a pipe vise and tighten tube on pipe, using a pipe wrench.

5. Measure the over-all length of the tube and pipe required (Step 2) and cut off the excess pipe.

6. Thread the remaining end of the pipe for a distance of at least 1".

7. Remove sharp edges from inside of pipe, using a rat-tail file.

8. Measure the distance obtained in Step 1 plus 1" from the end of the pipe. Scribe a line at this point.

9. Install a steel collar over the pipe and line up the lower edge of the collar with the scribed line (Step 8). Have welder tack-weld the upper side of the washer to the pipe.

10. Have the welder complete a 3/16" fillet-weld all around the collar as shown in Fig. 11.

11. Select a piece of galvanized steel pipe (I.P.S.) of sufficient size to fit over the riser pipe and of sufficient length to suit the thickness of insulation (less sheathing) minus $\frac{1}{4}$".

12. Cut one end of the pipe at right angles, using the power hack saw.

13. Install the pipe (Step 12) and a collar over a mandrel and butt the collar against the end of the pipe cut in Step 12. Have welder tack-weld collar and pipe together.

14. Remove mandrel and have welder complete a 3/16" fillet-weld all around collar and pipe as shown in Fig. 11.

15. Measure distance determined in Step 11 starting at the collar. Cut off the excess pipe.

16. Insert mandrel through collar and pipe (Step 15) and into hole in steel deck and butt pipe against the deck as shown in Fig. 11. Have welder tack-weld pipe to the deck.

17. Remove mandrel and have welder complete a 3/16" fillet-weld all around pipe at deck line as shown in Fig. 11.

18. Cut a canvas or canton flannel washer using the collar (Step 16) as a template.

19. Cut a canvas or canton flannel washer using the slip ring as a template.

20. Soak washers in raw linseed oil and allow them to dry.

21. Paint washers with heavy red lead.

22. After deck insulation and sheathing are installed place a canvas or canton flannel washer on collar on the riser pipe.

23. Insert riser pipe through collar and pipe that is welded to the deck until the collar on the riser pipe butts the collar on the pipe that is welded to the deck.

    Note: Canvas or canton flannel gasket is between both collars.

24. Install canvas or canton flannel gasket, slip ring and lock-nut on bottom of riser pipe as shown in Fig. 11.

25. Tighten lock-nut with an end wrench.

TABLE I - STUFFING TUBES

STANDARD SIZE DESIGNATON	ACTUAL C. M. AREA	TYPE CABLE																								
		SLPP	SLPA	DLPP	DLPA	TLPP	TLPA	SFPP	SFPA	DFPP	DFPA	TFPP	TFPA	FFPP	FFPA	SHFA	DHFA	THFA	FHFA	FLP	FLA	SRLL	SRHLA	DRHLA	DRLL	TRHLA
3	2,828	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	C	C	C	-	-	-	-	-	-	-
4	4,494	A	A	D	D	D	E	A	B	D	F	E	F	F	G	B	F	F	G	G	G	A	K	T	C	V
9	9,030	C	C	G	J	J	J	B	C	F	G	F	G	-	-	D	G	G	-	-	-	-	-	-	-	-
14	14,350	C	D	J	J	J	K	C	C	G	G	G	J	-	-	D	G	J	-	-	-	-	-	-	-	-
23	22,820	D	D	K	K	K	K	C	D	G	J	J	K	-	-	D	J	K	-	-	-	-	-	-	-	-
30	30,780	D	E	L	L	L	L	C	D	J	K	K	L	-	-	E	K	L	-	-	-	-	-	-	-	-
40	38,950	E	E	L	L	M	M	C	D	K	L	L	L	-	-	F	L	L	-	-	-	-	-	-	-	-
50	49,020	F	F	M	M	M	M	D	D	L	L	L	M	-	-	F	L	M	-	-	-	-	-	-	-	-
60	59,940	F	F	M	M	N	N	D	E	M	M	M	N	-	-	G	M	N	-	-	-	-	-	-	-	-
75	75,850	G	G	N	N	P	P	D	E	N	N	P	P	-	-	G	N	P	-	-	-	-	-	-	-	-
100	98,820	G	G	P	P	R	R	E	F	P	P	R	R	-	-	G	P	R	-	-	-	-	-	-	-	-
125	125,050	J	J	R	R	S	S	F	G	R	R	R	S	-	-	J	R	S	-	-	-	-	-	-	-	-
150	157,380	J	J	S	S	T	T	G	G	S	S	T	T	-	-	J	T	T	-	-	-	-	-	-	-	-
200	198,860	K	K	T	T	T	V	G	J	T	T	T	V	-	-	K	T	V	-	-	-	-	-	-	-	-
250	250,710	L	L	V	V	W	W	-	-	V	V	W	X	-	-	-	V	W	-	-	-	-	-	-	-	-
300	296,660	L	M	W	W	X	X	J	K	W	X	X	X	-	-	L	W	X	-	-	-	-	-	-	-	-
400	414,020	M	M	Y	Y	Z	Z	K	L	Y	Y	Z	Z	-	-	M	Y	Z	-	-	-	-	-	-	-	-
500	521,970	N	N	-	-	-	-	L	M	-	-	-	-	-	-	N	-	-	-	-	-	-	-	-	-	-
650	657,860	P	P	-	-	-	-	M	N	-	-	-	-	-	-	N	-	-	-	-	-	-	-	-	-	-
800	829,310	R	R	-	-	-	-	N	P	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-
1000	1,046,000	S	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1500	1,662,000	V	V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(continued on next page)

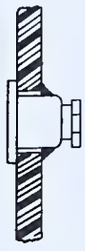
TABLE I - (continued)

STANDARD SIZE DESIGNATION	NUMBER OF CONDUCTORS OF PAIRS	TYPE CABLE										
		GICP	GICA	GICF	MFPP	MFPA	MHFA	MCP	TPTP	TPTA	TTHFA	MCMB
1	1	-	-	-	-	-	-	-	-	A	B	-
2	2	C	C	B	D	D	C	-	-	-	-	-
3	3	-	-	-	-	-	-	-	B	B	C	-
4	4	E	F	-	D	E	C	C	-	-	-	-
5	5	-	-	-	-	-	-	C	D	D	C	-
7	7	G	G	C	F	G	G	C	-	-	-	D
10	10	J	J	F	J	J	K	D	E	E	D	-
12	12	-	-	-	-	-	-	D	-	-	-	-
14	14	K	K	J	K	K	K	-	-	-	-	-
15	15	-	-	-	-	-	-	-	F	F	E	-
19	19	L	L	M	K	L	L	-	-	-	-	-
20	20	-	-	-	-	-	-	-	G	G	F	-
22	22	M	M	N	M	M	M	-	-	-	-	-
25	25	-	-	-	-	-	-	-	G	G	G	-
26	26	M	M	N	M	N	N	-	-	-	-	-
30	30	N	N	P	N	N	N	-	G	J	G	-
37	37	N	N	P	P	P	P	-	-	-	-	-
40	40	-	-	-	-	-	-	-	J	J	J	-
44	44	P	P	R	R	S	S	-	-	-	-	-
50	50	-	-	-	-	-	-	-	K	K	J	-
60	60	-	-	-	-	-	-	-	K	K	L	-

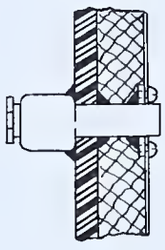
STANDARD SIZE DESIGNATION	TYPE CABLE			
	SCP	DCP	TCP	
1	-	A	A	
1-1/2	-	A	-	
2	-	A	A	
2-1/2	-	A	-	
3	-	B	A	
4	-	B	B	
6	-	C	C	
8	-	-	-	
9	-	C	C	
13	-	-	-	
14	-	G	-	
21	-	-	-	
23	-	K	-	
30	-	L	-	
40	-	-	M	
150	-	-	S	
250	-	V	W	
400	-	Y	Z	
650	-		-	
800	T	-	-	

STUFFING TUBES - CABLE ASSIGNMENT
Data from 9-s-4680-L & 9-S-5166-L

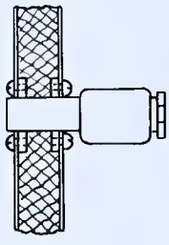
XXX-1
DECKS AND BULKHEADS 3/4" THICKNESS AND UNDER



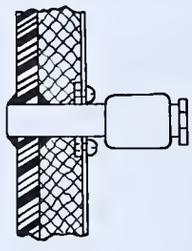
XLVII-1
DECKS OR BULKHEADS OVER 3/4" WITH OR WITHOUT INSULATION



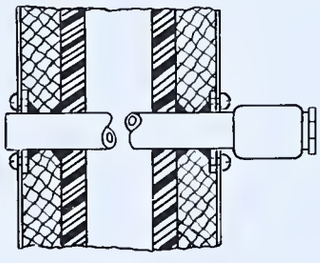
XLIX-4
PARTITION BULKHEAD (REFRIGERATING SPACE)



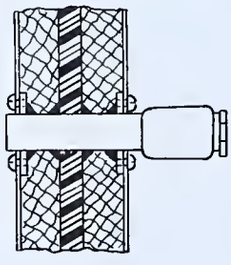
XLIX-1
BULKHEADS WITH INSULATION ONE SIDE (REFRIGERATING SPACE)



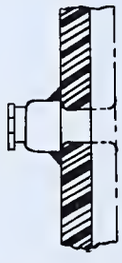
XLIX-3
BULKHEADS WITH INSULATION INCLUDING AIR CASING WITH INSULATION



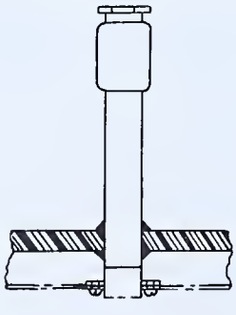
XLIX-2
BULKHEADS WITH INSULATION TWO SIDES (REFRIGERATING SPACE)



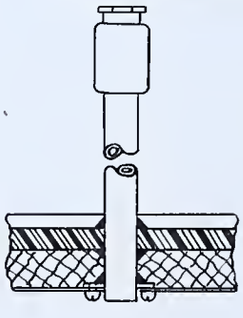
XXX-1A
ARMORED DECKS AND S.T.S BULKHEADS (SINGLE OR WITH DOUBLER PLATES)



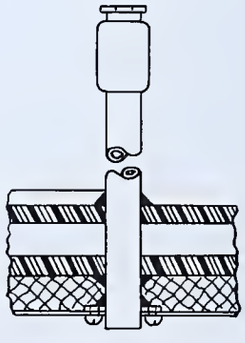
XLVIII-1
DECKS WITH OR WITHOUT INSULATION (INCLUDING WEATHER DECKS AND REFRIGERATING SPACES)



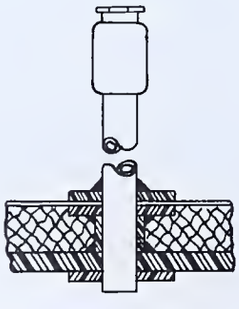
XLVIII-2
DECKS WITH COVERING AND WITH OR WITHOUT INSULATION (INCLUDING WEATHER DECKS)



XLVIII-3
DECKS WITH OR WITHOUT COVERING INCLUDING AIR CASING WITH INSULATION



XLVIII-4
DECKS WITH TOP INSULATION



XLVIII-1A
ARMORED DECKS SINGLE OR WITH DOUBLER PLATES

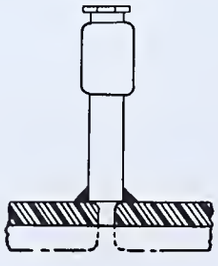


TABLE NO. II
(continued)

APPLICATION OF STUFFING TUBES (STEEL)
For Steel Decks and Bulkheads

		For use with Type XXX Tubes only		For use with Type XLVII, XLVIII and XLIX Tubes only		
STUFFING TUBE SIZE	DIA. HOLE FOR CABLE (inches)	OUTSIDE DIA. OF BODY (inches)	OUTSIDE DIA. OF FLANGE (inches)	OUTSIDE DIA. OF TUBE (inches)	PIPE SIZE (I.P.S.) (inches)	OUTSIDE DIA. OF (I.P.S.) PIPE (inches)
A	0.406	1- 1/4	1- 5/8	1- 1/8	3/8	5/8
B	0.515	1- 3/8	1- 3/4	1- 1/4	1/2	27/32
C	0.640	1- 1/2	1- 7/8	1- 3/8	3/4	1- 3/64
D	0.750	1- 5/8	2	1- 1/2	3/4	1- 3/64
E	0.796	1- 5/8	2	1- 1/2	3/4	1- 3/64
F	0.843	1-11/16	2- 1/16	1- 5/8	1	1- 5/16
G	0.953	2	2- 3/8	1-13/16	1	1- 5/16
J	1.062	2- 1/8	2- 1/2	2	1-1/4	1-21/32
K	1.171	2- 1/4	2- 5/8	2- 1/16	1-1/4	1-21/32
L	1.265	2- 5/16	2-11/16	2- 1/8	1-1/4	1-21/32
M	1.406	2- 1/2	2- 7/8	2- 5/16	1-1/2	1-29/32
N	1.515	2-11/16	3- 1/16	2- 7/16	1-1/2	1-29/32
P	1.625	2-13/16	3- 3/16	2- 3/4	2	2- 3/8
R	1.750	2-15/16	3- 5/16	2- 3/4	2	2- 3/8
S	1.875	3- 5/16	3-11/16	3- 1/16	2	2- 3/8
T	2.062	3- 1/2	3- 7/8	3- 1/4	2-1/2	2- 7/8
V	2.187	3- 5/8	4	3- 3/8	2-1/2	2- 7/8
W	2.312	3- 3/4	4- 1/8	3- 1/2	2-1/2	2- 7/8
X	2.500	3- 7/8	4- 1/4	3- 7/8	3	3- 1/2
Y	2.609	4	4- 3/8	3- 7/8	3	3- 1/2
Z	2.781	4- 3/16	4- 9/16	3-15/16	3	3- 1/2

FOR PROPER SIZE STUFFING TUBE TO USE WITH ANY PARTICULAR TYPE AND SIZE OF CABLE, SEE TABLE I

NOTES:

1. FOR ALUMINUM DECKS AND BULKHEADS, USE ALUMINUM STUFFING TUBES TYPES XLII, XLIII, XLIV AND XLV. SEE TABLE III FOR APPLICATION.

2. FOR BRASS DECKS AND BULKHEADS, USE BRASS STUFFING TUBES TYPES XXXV, XXXVI XXXVII AND XXXVIII. SEE TABLE IV FOR APPLICATION.

3. ALL KICKPIPES AND RISERS SHALL BE GALVANIZED STEEL PIPE, EXCEPT IN VICINITY OF MAGNETIC COMPASS, WHERE ALUMINUM SHALL BE USED.

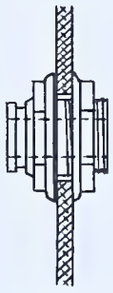
4. IN LOCATIONS WHERE SIX OR MORE CABLES PASS THROUGH A DECK IN A GROUP, BULKHEAD TYPE STUFFING TUBES SHALL BE USED, AND THE CABLES PROTECTED WITH A COMMUNITY RISER.

5. WHERE LESS THAN SIX CABLES PASS THROUGH A DECK IN A GROUP, DECK TYPE STUFFING TUBES WITH KICKPIPES SHALL BE USED.

6. WHERE THREE OR MORE CABLES PASS THROUGH INSULATED DECKS OR BULKHEADS IN A GROUP, THE INSULATION SHALL BE CUT AWAY AND THE STANDARD TUBE FOR DECKS AND BULKHEADS WITHOUT INSULATION, SHALL BE USED.

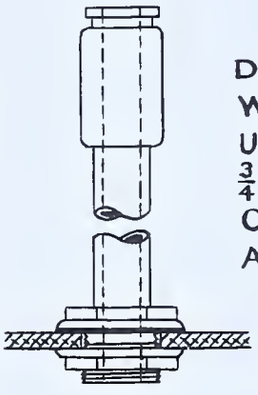
TABLE III

APPLICATION OF STUFFING TUBES (ALUMINUM)
For Aluminum Decks, Bulkheads and Plates.
(Derived from Bureau of Ships Drawing No. 9-S-4950-L)

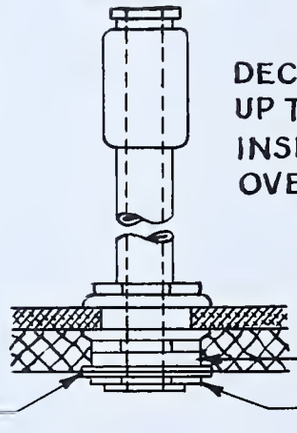


DECKS, BHDS. AND PLATES - WITHOUT INSULATION UP TO $\frac{3}{4}$" THICK, TYPE XLII $\frac{3}{4}$" TO $1\frac{1}{2}$" THICK, TYPE XLIV OMITTING NUT, WASHERS AND SPACER.

DECKS, BHDS. AND PLATES UP TO $\frac{9}{16}$" THICK WITH INSULATION UP TO $1\frac{5}{8}$" OVERALL, TYPE XLIV.



DECKS AND PLATES WITHOUT INSULATION UP TO $\frac{3}{4}$" THICK, TYPE XLIII $\frac{3}{4}$" TO $1\frac{1}{2}$" THICK, TYPE XLV OMITTING NUT, WASHERS AND SPACERS.



DECKS AND PLATES UP TO $\frac{9}{16}$" THICK WITH INSULATION UP TO $1\frac{5}{8}$" OVERALL, TYPE XLV.

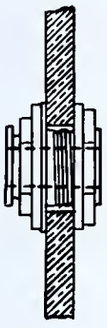
STUFFING TUBE SIZE	DIA. HOLE REQ'D FOR CABLE (inches)	DIA. HOLE REQ'D FOR TUBE (inches)	LARGEST OUTSIDE DIA. (inches)	I.P.S. OF KICKPIPE (inches)
A	0.406	1- 3/8	2- 1/4	3/8
B	0.515	1- 1/2	2- 3/8	1/2
C	0.640	1- 5/8	2- 9/16	3/4
D	0.750	1- 3/4	2-11/16	3/4
E	0.796	1- 3/4	2-11/16	3/4
F	0.843	1-13/16	2- 3/4	1
G	0.953	2- 1/16	3- 1/16	1
J	1.062	2- 3/16	3- 3/16	1-1/4
K	1.171	2- 5/16	3- 1/2	1-1/4
L	1.265	2- 3/8	3- 9/16	1-1/4
M	1.406	2- 5/8	3- 7/8	1-1/2
N	1.515	2-11/16	3-15/16	1-1/2
P	1.625	2- 7/8	4- 3/16	2
R	1.750	3	4- 3/8	2
S	1.875	3- 7/16	4- 7/8	2
T	2.062	3- 5/8	5- 1/16	2-1/2
V	2.187	3-13/16	5- 5/16	2-1/2
W	2.312	3-15/16	5- 1/2	2-1/2
X	2.500	4- 1/8	5- 7/8	3
Y	2.609	4- 1/4	6	3
Z	2.781	4- 7/16	6- 3/16	3

FOR PROPER SIZE STUFFING TUBE TO USE WITH ANY PARTICULAR TYPE AND SIZE OF CABLE, SEE TABLE I.

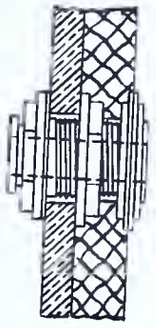
FOR NOTES, SEE TABLE II.

TABLE IV

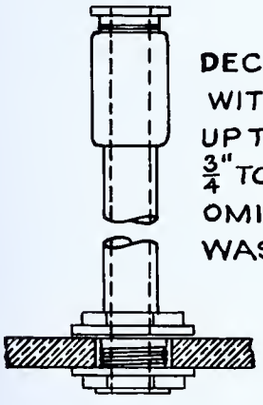
APPLICATION OF STUFFING TUBES (BRASS)
For Brass Decks, Bulkheads and Plates
(Derived from Bureau of Ships Drawing No. 9-S-4681-L)



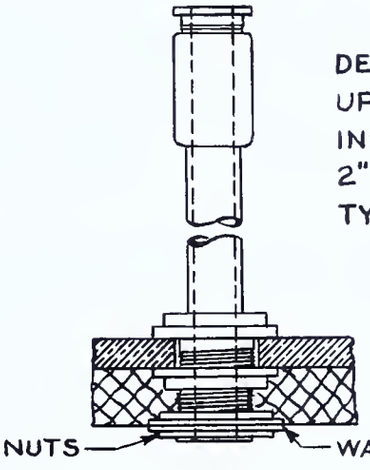
DECKS, BHDS AND PLATES WITHOUT INSULATION UP TO $\frac{3}{4}$" THICK, TYPE XXXV
$\frac{3}{4}$" TO $1\frac{7}{8}$" THICK, TYPE XXXVII
OMITTING NUTS AND WASHERS.



DECKS, BHDS AND PLATES UP TO $\frac{3}{4}$" THICK WITH INSULATION UP TO 2" OVERALL, USE TYPE XXXVII.



DECKS AND PLATES WITHOUT INSULATION UP TO $\frac{3}{4}$" THICK, TYPE XXXVI
$\frac{3}{4}$" TO $1\frac{7}{8}$" THICK, TYPE XXXVIII
OMITTING NUTS AND WASHERS.



DECKS AND PLATES UP TO $\frac{3}{4}$" THICK WITH INSULATION UP TO 2" OVERALL, USE TYPE XXXVIII.

STUFFING TUBE SIZE	DIA. HOLE REQ'D FOR CABLE (inches)	DIA. HOLE REQ'D FOR TUBE (inches)	LARGEST OUTSIDE DIA. (inches)	I.P.S. OF KICKPIPE (inches)
A	0.406	1- 3/8	2- 1/4	3/8
B	0.515	1- 1/2	2- 3/8	1/2
C	0.640	1-11/16	2- 9/16	3/4
D	0.750	1- 3/4	2- 5/8	3/4
E	0.796	1- 3/4	2- 5/8	3/4
F	0.843	2	2- 7/8	1
G	0.953	2- 1/16	3- 1/16	1
J	1.062	2- 3/8	3- 3/8	1-1/4
K	1.171	2- 3/8	3- 3/8	1-1/4
L	1.265	2- 7/16	3- 7/16	1-1/4
M	1.406	2- 5/8	3- 5/8	1-1/2
N	1.515	2-13/16	4- 1/16	1-1/2
P	1.625	3- 1/16	4- 5/16	2
R	1.750	3- 1/16	4- 5/16	2
S	1.875	3- 5/16	4- 9/16	2
T	2.062	3-11/16	5	2-1/2
V	2.187	3- 3/4	5- 1/16	2-1/2
W	2.312	3- 3/4	5- 1/16	2-1/2
X	2.500	4- 5/16	5-15/16	3
Y	2.609	4- 5/16	5-15/16	3
Z	2.781	4- 5/16	5-15/16	3

FOR PROPER SIZE STUFFING TUBE TO USE WITH ANY PARTICULAR TYPE AND SIZE OF CABLE, SEE TABLE I.

FOR NOTES SEE TABLE II
Page 37

QUESTIONS

Place the answers to these questions in your notebook or on form as directed by instructor.

1. Where and why are stuffing tubes installed?

2. (a) Name three kinds of metal from which stuffing tubes are made.

   (b) Name the kinds of metal decks and bulkheads associated with these tubes.

3. What compound is applied to all threads before assembly? Why?

4. Outline the steps for the installation of a stuffing tube in a 3/4" steel bulkhead without insulation.

5. (a) What precautions must be taken by the electrician in regard to the packing nut and the body of the tube before welding to the bulkhead or deck?

   (b) Why?

6. (a) What is a "kickpipe"?

   (b) Where is it used?

   (c) What is its purpose?

   (d) How does it differ from a stuffing tube?

HOW TO PACK A TERMINAL TUBE AND A STUFFING TUBE

General Information:

After the installation of terminal tubes and stuffing tubes, as outlined in Units 11 and 12, cable that has been painted with waterproof paint is pulled through the tube and the tube is packed. One of the essential points of tube installations is that the tubes be carefully packed to obtain watertight, gastight, fumetight, and oiltight results.

Terminal tubes and stuffing tubes are packed in the same manner. There are four types of packing that are most commonly used:

a. Hard Graphite Fibrous Braid is used for the bottom and top pieces in the packing gland as a retainer for the soft packing.

b. Soft Graphite Fibrous Braid is used as the sealer; when the gland nut is tightened, the soft packing is compressed tightly against the cable and the wall of the packing gland, thereby making the tube watertight, gastight, fumetight, and oiltight.

c. Metallic Packing is substituted for hard packing where it is necessary to ground the armor of the cable to the ship's structure through the terminal tube or stuffing tube. Cables that require grounding are those subjected to radio frequencies. Cable is to be scraped free of paint, rust, etc., at the point where metallic packing is to contact.

d. Rubber Packing is used where very flexible cables (rubber covered) are passed through a tube. No other packing is required in this type of installation.

Tools:

Knife or cutting pliers
Hammer
Tamping tool
End wrench

Materials:

Hard packing
Soft packing
Metallic packing
Rubber packing
Plastic sealer
Electrical insulator
5 ft. piece - MHFA-10
Term. Tube Type XXI
size J

TO PACK A TERMINAL TUBE OR STUFFING TUBE:

The most commonly used packing increases in size in Steps of 1/16" from 1/8" in diameter to 7/16" in diameter, except for rubber packing. (Square rubber packing is used.) The proper size to be used is determined by the clearance between the cable and the wall of the packing gland.

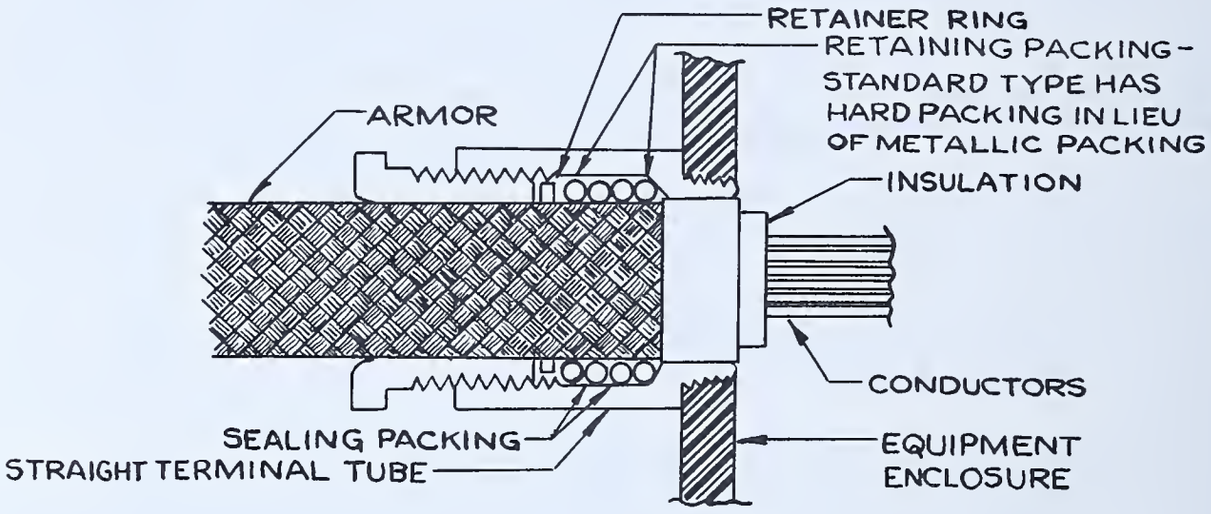


FIG. 1

Procedure:

1. Cut two lengths of hard packing - each length equal to the circumference of the cable. See Fig. 2.

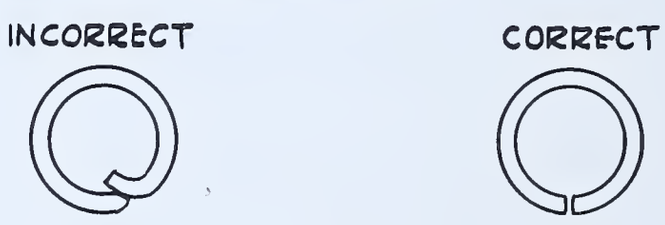
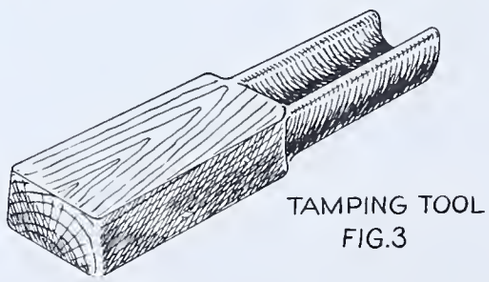


FIG. 2

2. Wrap one piece of hard packing around the cable at the opening of the tube and tamp into the packing gland with the tamping tool. This is a wooden device illustrated in Fig. 3.



TAMPING TOOL
FIG.3

3. Cut as many lengths or "rings" of soft packing as the type tube requires (average tube requires about 2 to 5 lengths). Each length is equal to the circumference of the cable.

4. Wrap one piece of soft packing around the cable and tamp into tube.

5. Repeat Step 4 with additional packing, one at a time, until the tube is packed to a position that will permit the installation of one piece of hard packing and the retainer ring, and still leave one thread of the tube body uncovered.

   Note: Care must be exercised by the electrician to place the joints of the successive pieces of packing about 90° apart, to insure watertightness, etc. See Fig. 4.

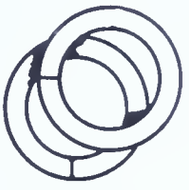


FIG. 4

6. Insert the second piece of hard packing and tamp into position.

7. Slide the retainer ring into the stuffing tube.

8. Insert the gland nut into the tube and tighten with an end wrench until four threads are showing out of the tube.

9. Remove the gland nut and retainer ring.

10. Fill the tube with plastic sealer electrical insulator.

    Note: Plastic sealer electrical insulator is used to prevent moisture from entering the packing; it also serves vermin proofing purposes.

11. Re-insert the gland nut and retainer ring, tightening until one and one-half or two threads are showing out of the tube.

    Note: The plastic sealer will fill the space between the cable and the clearance hole of the gland nut and will appear on the surface of the gland nut.

12. Smooth the plastic sealer around the gland nut with one finger.

QUESTIONS

Place the answers to these questions in your notebook or on form as directed by instructor.

1. What is the purpose of packing a terminal or stuffing tube?
2. Name four of the most commonly used types of packing.
3. Outline the procedures for packing a tube, using two kinds of packing.
4. (a) When is plastic sealer electrical insulator applied?
   (b) What is its purpose?

HOW TO SELECT AND INSTALL CABLE CLAMPS

General Information:

Cable clamps are installed in branch boxes, distribution boxes, junction boxes, lighting fixtures, and appliances and power equipment of non-watertight design, to secure the cable in place and to prevent the possibility of the cable being pulled out of the enclosure.

Tools and Equipment:

- Center punch
- Hammer
- End wrench
- Screw driver
- 12" metal rule
- Cable clamp pliers
- Scribe
- Drill press
- Drills (various sizes)
- Draw rivet set
- Cable mandrel (various sizes)

Materials:

- Rivets, round head aluminum (various sizes and lengths)
- Cable clamps (various sizes of Types A and B)
- Plastic Sealer Electrical Insulator
- 5 ft. piece THFA-9
- Machine screws and hex. nuts (various sizes and lengths)
- Non-watertight appliances of various thicknesses of metal (1/16", 1/8" and 1/4" sheet metal may be used to simulate enclosures)

TO SELECT THE PROPER SIZE AND TYPE CABLE CLAMP:

Note: Tables I, II and III are used in conjunction with Navy type cables, and are derived from U. S. Navy Bureau of Ships drawings 9-S-4562-L and 9-S-4798-L as indicated.

1. Size of Cable Clamp - refer to Tables I and II

On Tables I and II find standard size designation of cable from Column 2. Follow across this line until the column for the type of cable is reached. The cable clamp size is designated by the letter at this intersection.

Example: Find the cable clamp size for a TLPA-9 cable. In Column 2, find the standard size designation. Follow this line across to the TLPA cable column. At this intersection, the letter PII appears. Therefore, PII is the size of the cable clamp.

2. Type of Cable Clamp - refer to Table III, Note 2.

From the above, a TLPA-75 cable that is to center a non-watertight equipment requires a Type A, Size PII cable clamp.

TO INSTALL A CABLE CLAMP:

1. Determine the "Clearance Hole Drill Diameter" from Table III for the particular size clamp. This information permits the spotting of the clamp on the side of equipment to be used.

Example: Using the cable clamp referred to, it is found that size PII requires a hole 1-9/64" diam. (use 1-1/4").

Note: On an equipment supplied with a "boss", the clamp should be spotted thereon.

2. Determine the location for the clamp, then mark and punch the center of location on the side of the equipment.

3. Drill clearance hole through the side of the equipment.

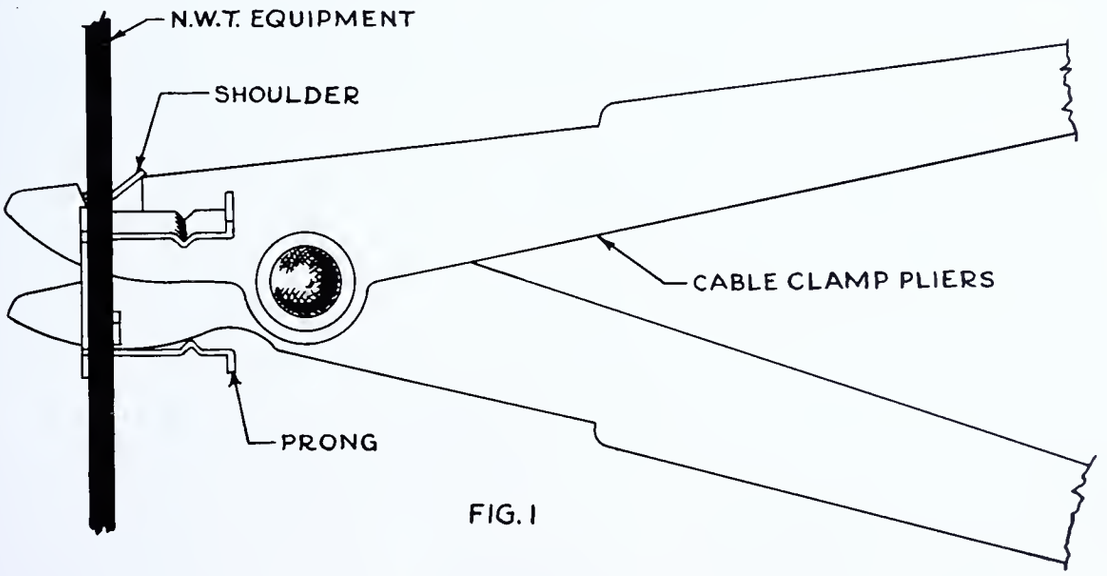


FIG. 1

A. Type "A" Installation

4. Insert cable clamp body into the clearance hole until the prong shoulders are against the inside of the equipment.

5. Hold the clamp firmly against the equipment and bend down against the inside of equipment wall, using cable clamp pliers as shown in Fig. 1.

6. Prepare cable.

7. Insert cable through the clamp. See Fig. 2.

   Note: Armor of cable is to be flush with inside wall of equipment, and insulation projects approx. 1/8" beyond inside wall as shown in Fig. 2.

8. Slip the clamp strap over the body and tighten screw on the strap.

9. Apply plastic sealer electrical insulator in sufficient quantity, entirely over the clamp (outside of equipment) to make the job drip-proof and vermin-proof.

A typical Type "A" installation is shown in Fig. 2.

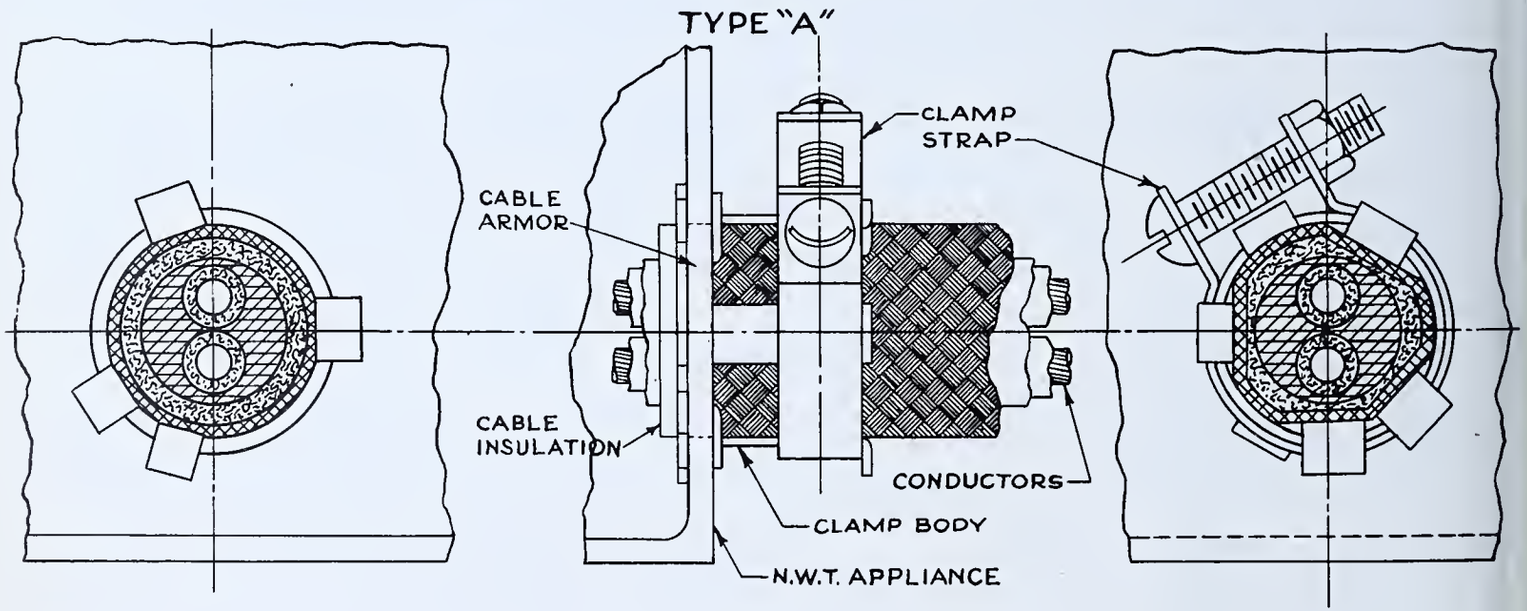


FIG.2

B. Type "B" Installation

4. Insert mandrel, size of cable to be used, into cable clamp, and tighten strap.

5. Insert mandrel into hole drilled in equipment as shown in Fig. 3.

6. Mark the four holes of prongs on the side of the equipment and center punch.

7. Drill clearance holes, or drill and tap the holes as required to suit the following conditions.

Method I. When the equipment is of very thin sheet metal, machine screws and hexagon nuts are used to hold the prongs in place.

Method II. When equipment is of sheet metal of less than 1/8" thickness, round head aluminum rivets may be used to hold the prongs in place.

Method III. When equipment is of sheet metal backed by reinforcing plates, or of cast material of 1/8" thickness or over, machine screws are inserted into drilled and tapped holes to hold the prongs in place.

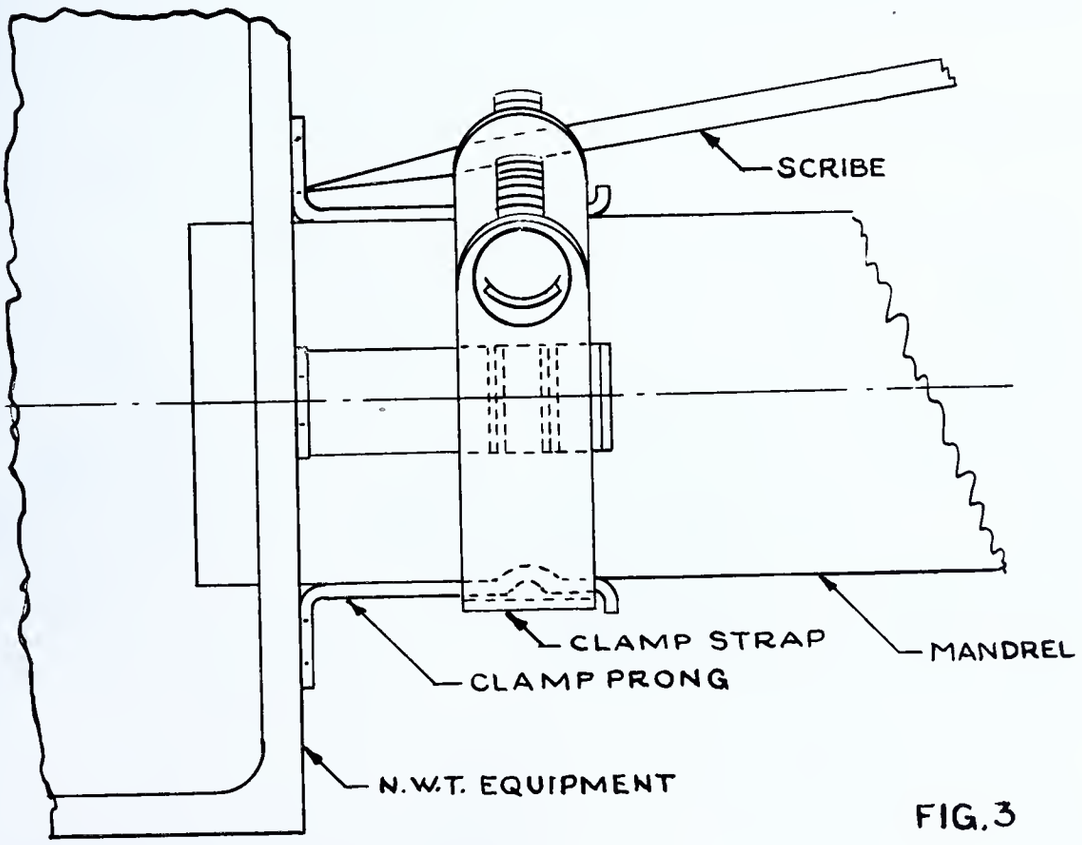


FIG. 3

8. Remove mandrel from clamp body, causing clamp to disassemble.

9. Place the prongs of the clamp against the equipment and insert round head rivets or machine screws through the holes in the prongs into the holes in the equipment, and then tighten.

10. For the various types of installation, the following must be accomplished:

    (a) Where Method I is used, install nut on screw from inside the enclosure and tighten with an end wrench.

    (b) Where Method II is used, round off rivet from the inside of the enclosure, using a draw rivet set as shown in Fig. 4.

    (c) Where Method III is used, tighten the screw in the drilled and tapped hole, using a screw driver.

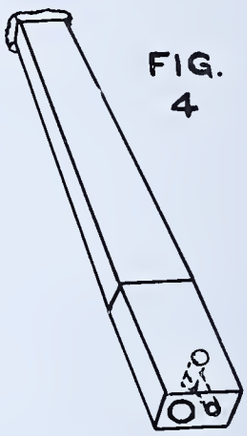


FIG. 4

11. Slip the clamp strap over the prongs.

12. Insert the cable through the clamp and tighten the screw on the strap, using a screw driver.

13. Apply plastic sealer electrical insulator in sufficient quantity over the clamp to make the job drip-proof.

A typical Type "B" installation, showing the various methods of securing the prongs, is shown in Fig. 5.

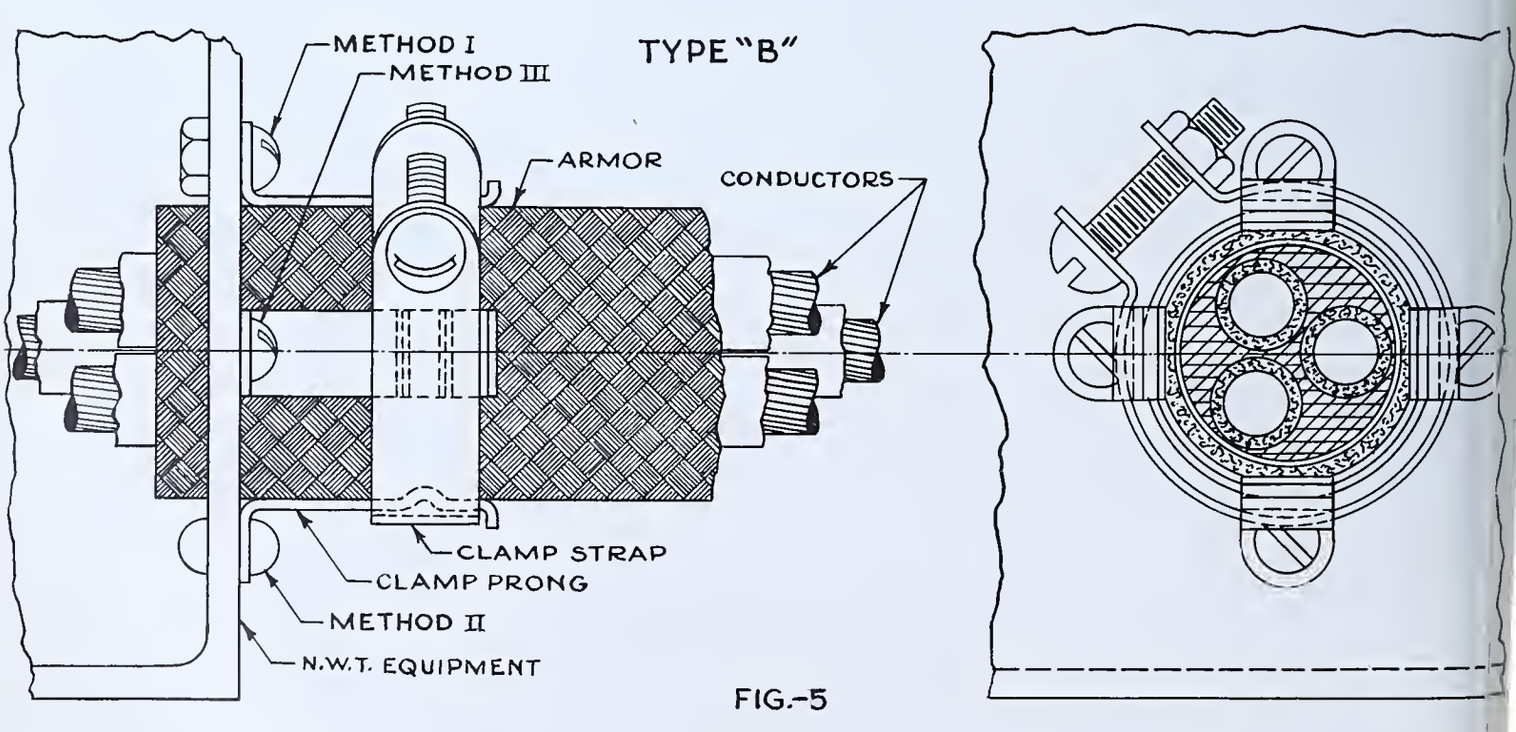


FIG.-5

TABLE I

Actual C.M. Area	Standard Size Designation	TYPE CABLE																							
		SLPP	SLPA	DLPP	DLPA	TLPP	TLPA	SFPP	SFPA	DFPP	DFPA	TFPP	TFPA	FFPP	FFPA	SHFA	DHFA	THFA	FHFA	FLP & FLA	SRLL	SRHLA	DRHLA	DRLL & TRLL	TRHLA
2,828	3															A	D	E	F						
4,494	4	AA	AA	H	J	J	K1	A	B	J	K11	K1	M	L	N	C11	K11	M	N	O	AA	W1	Y11	D	Y12
9,030	9	F	F	P1	P1	P11	P11	C11	E	K11	M	L	O			G	M	O							
14,350	14	F	G	P11	Q1	Q11	Q11	D	F	N	P1	O	P11			H	P1	P11							
22,820	23	G	H	W1	W1	W1	W2	E	G	P1	Q1	P11	Q11			J	Q1	Q11							
30,780	30	J	K1	W2	W2	W3	W3	F	G	Q11	W1	W1	W2			K1	W1	W2							
38,950	40	K1	K1	W3	W3	W4	W4	F	H	W1	W2	W2	W3			K11	W2	W3							
49,020	50	K11	L	W4	W4	W5	W5	G	J	W2	W3	W3	W4			L	W3	W4							
59,940	60	L	M	W5	W5	W5	W5	H	K1	W4	W4	W5	W5			M	W5	W5							
75,850	75	N	N	X6	X6	X6	X7	J	K11	W5	X6	X6	X7			N	X6	X7							
98,820	100	O	O	X7	X7	X8	X8	K1	L	X6	X7	X8	X8			O	X7	X8							
125,050	125	P11	P11	X8	X8	Y9	Y9	L	N	X7	X8	Y9	Y9			P11	X8	Y9							
157,380	150	Q1	Q11	Y9	Y9	Y10	Y10	M	O	Y9	Y10	Y10	Y11			Q1	Y10	Y11							
198,860	200	W1	W1	Y10	Y10	Y11	Y11	O	P11	Y10	Y11	Y11	Y12			W1	Y11	Y12							
250,710	250	W2	W2	Y12	Y12	Y13	Y13			Y12	Y12	Y13	Y13				Y12	Y13							
296,660	300	W3	W3	Y13	Y13	Z14	Z14	Q1	W1	Y13	Z14	Z14	Z15			W2	Y13	Z15							
414,020	400	W5	W5	Z15	Z15	Z16	Z16	W1	W2	Z15	Z15	Z16	Z16			W4	Z15	Z16							
521,970	500	X6	W6					W3	W4							W5									
657,860	650	X7	X7					W4	W5							X6									
829,310	800	X8	X8					W5	X6							X7									
1,046,000	1000	Y10	Y10																						
1,662,000	1500	Y12	Y12																						

TABLE II

Standard Size Designation	Number of Conductors or Pairs	TYPE CABLE										
		GICP	GICA	GICF	MFPP	MFPA	MHFA	MCP	TPTP	TPTA	TTHFA	MCMB
1	1	-	-	-	-	-	-	-	-	B	C-II	-
2	2	D	E	C-I	F	G	H&D	-	-	-	-	-
3	3	-	-	-	-	-	-	-	C-I	C-II	E	-
4	4	K-I	K-II	-	G	K-I	K-II	C-II	-	-	-	-
5	5	-	-	-	-	-	-	E	G	H	F	-
7	7	M	N	F	K-I	M	N	F	-	-	-	H
10	10	Q-I	Q-II	L	P-I	P-II	Q-II	H	K-I	K-II	H	-
12	12	-	-	-	-	-	-	J	-	-	-	-
14	14	W1	W1	P-I	P-II	Q-II	W1	-	-	-	-	-
15	15	-	-	-	-	-	-	-	L	L	K-I	-
19	19	W2	W2	W4	W1	W2	W3	-	-	-	-	-
20	20	-	-	-	-	-	-	-	M	N	L	-
22	22	W4	W4	W5	W2	W4	W5	-	-	-	-	-
25	25	-	-	-	-	-	-	-	O	O	M	-
26	26	W4	W4	X6	W4	W4	W5	-	-	-	-	-
30	30	W5	W5	X6	W4	W5	X6	-	P-I	P-I	N	-
37	37	X6	X6	X6	W5	X6	X7	-	-	-	-	-
40	40	-	-	-	-	-	-	-	Q-I	Q-I	P-I	-
44	44	X7	X7	X8	X7	X7	Y9	-	-	-	-	-
50	50	-	-	-	-	-	-	-	W1	W1	Q-I	-
60	60	-	-	-	-	-	-	-	W1	W1	W2	-

Standard Size Designation	TYPE CABLE		
	SCP	DCP	TCP
1	-	AA	AA
1 1/2	-	A	-
2	-	A	A
2 1/2	-	-	-
3	-	C-I	B
4	-	C-II	C-II
6	-	D	D
8	-	-	-
9	-	D	E
13	-	-	-
14	-	P-I	-
21	-	-	-
23	-	W1	-
30	-	W2	-
40	-	-	W4
150	-	-	Y10
250	-	Y12	Y13
400	-	Z15	-
650	-	-	-
800	Y10	-	-

APPLICATION OF CABLE CLAMPS TYPES A AND B
(STEEL)
TABLE III

TYPE A 9S-4562-L		
SIZE CABLE CLAMP	DIA. HOLE FOR CABLE (inches)	CLEAR. HOLE DRILL DIA. (inches)
AA	0.296	3/8
A	0.343	27/64
B	0.421	1/2
C-I	0.453	17/32
C-II	0.500	37/64
D	0.531	39/64
E	0.562	41/64
F	0.609	11/16
G	0.656	47/64
H	0.687	49/64
J	0.718	51/64
K-I	0.748	27/32
K-II	0.779	7/8
L	0.810	29/32
M	0.841	15/16
N	0.873	31/32
O	0.904	1
P-I	0.951	1- 3/64
P-II	0.982	1- 5/64
Q-I	1.013	1- 7/64
Q-II	1.045	1- 9/64

TYPE B 9S-4798-L		
SIZE CABLE CLAMP	DIA. HOLE FOR CABLE (inches)	CLEAR. HOLE DRILL DIA. (inches)
W1	1.109	1- 7/64
W1	1.140	1- 9/64
W2	1.171	1-11/64
W2	1.203	1-13/64
W3	1.250	1- 1/4
W4	1.296	1-19/64
W4	1.343	1-11/32
W5	1.375	1- 3/8
W5	1.406	1-13/32
W5	1.437	1- 7/16
X6	1.484	1-31/64
X6	1.531	1-17/32
X7	1.562	1- 9/16
X7	1.609	1-39/64
X8	1.640	1-41/64
X8	1.703	1-45/64
Y9	1.734	1-47/64
Y9	1.796	1-51/64
Y10	1.859	1-55/64
Y10	1.921	1-59/64
Y10	1.937	1-15/16
Y11	1.968	1-31/32
Y11	2.046	2- 3/64
Y12	2.109	2- 7/64
Y12	2.156	2- 5/32
Y13	2.250	2- 1/4
Y13	2.281	2- 9/32
Z14	2.390	2-25/64
Z15	2.453	2-29/64
Z15	2.515	2-33/64
Z16	2.687	2-11/16

NOTES:

1. CABLE CLAMPS ARE TO BE USED TO SECURE CABLES WHERE THEY ENTER THE SIDES OR BOTTOM OF N.W.T. APPLIANCES. (USE TERMINAL TUBES WHEN CABLES ENTER THE TOP.)

2. SIZES AA TO Q-II INCLUSIVE ARE TYPE A AND ARE SHOWN ON 9S-4562-L. SIZES W1 TO Z16 INCLUSIVE ARE TYPE B AND ARE SHOWN ON 9S-4798-L.

3. TYPE B CABLE CLAMPS MAY BE INSTALLED BY TWO METHODS: METHOD I USING MACHINE SCREWS AND, IN CASES WHERE THE MATERIAL IS VERY THIN, HEX NUTS: METHOD II USING ALUMINUM ROUND HEAD RIVETS. METHOD III IS USED FOR METAL 1/8" OR OVER, OR WHERE THE THIN METAL IS REINFORCED BY STIFFENING PLATES.

QUESTIONS

Place the answers to these questions in your notebook or on form as directed by instructor.

1. What is the purpose of a cable clamp?

2. Where is the proper place to install a clamp on an appliance?

3. How is a Type "A" clamp installed?

4. How is a Type "B" clamp installed on:

   (a) A very thin sheet metal appliance?

   (b) A sheet metal appliance less than 1/8" thick?

   (c) A sheet metal or cast material appliance of 1/8" thickness or over?

HOW TO SELECT AND INSTALL A BUSHING

General Information:

Where a cable penetrates a non-watertight bulkhead or beam that is 1/4" thick or under, a bushing is installed to prevent chafing of cable.

Where a cable penetrates a non-watertight bulkhead or beam that is over 1/4" thick, the installation of a bushing is not required, but a hole, slightly larger in diameter than the cable, is drilled and the edges rounded off to prevent chafing of the cable.

When installing a bushing in a bulkhead, a minimum distance of 3" must be maintained between the bushing and the adjoining deck or bulkhead. See Fig. 1.

Whenever more than one bushing is installed (adjacent to each other) in a bulkhead, or beam, the "60-40" rule must be followed for spacing. For use of the "60-40" rule refer to Unit 16. The location of the drilled hole or holes in a beam must be slightly above the center of the beam.

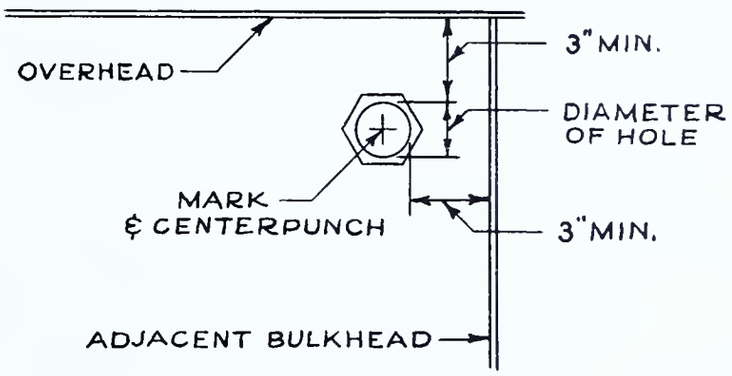


FIG. 1

Tools:

6' folding rule
12" metal scale
Center punch
Hammer
End wrench
White chalk, or soapstone
Yellow crayon

Materials:

Metal washers
Bushings
Petrolatum and zinc dust compound
5 ft. length THFA-9

Associated Trades:

Driller
Sheet metal worker

To Select the Proper Size Bushing:

Note: Table I is used in conjunction with Navy Type cables and is derived from U. S. Navy Bureau of Ships drawing 9-S-4268-L. To secure size of bushings refer to Tables I and II of this unit.

1. On Table I, find the standard size designation of the cable from Column 2. Follow across this line until the column for the type of cable is reached. The bushing size is designated by the letter at this intersection.

   Example: Find the bushing size for Type TLPA-4 cable. In Column 2, find the standard size designation 40. Follow this line across to the TLPA-4 cable column. At this intersection the letter "E" is noted. Therefore "E" is the size of the bushing.

2. Type of Bushing:

   Bushings used in Naval construction are of aluminum and are designated as Type IV.

3. From the above, a TLPA-4 cable that is to penetrate a non-watertight bulkhead or beam requires a Type IV, Size "E" bushing.

TO INSTALL A BUSHING:

1. Determine the size designation of the bushing from Table I, Page 98.

2. Determine the "Diameter Hole for Bushing" and "Hex. Nut Across Flats" from Table III, Page 100, for the particular size bushing. This information permits spotting of the bushing on a bulkhead or beam so as to give a sufficient clearance from adjacent obstructions.

3. Determine the location for the bushing, mark and punch the center location on solid metal bulkhead or beam. See Fig. 1.

   Note: For wire mesh bulkheads, the "Diameter Hole for Bushing" is marked with white chalk or yellow crayon.

4. Have solid metal bulkhead or beam drilled by a driller, or a hole cut in the wire mesh bulkhead by a sheet metal worker to the size of the "Diameter Hole for Bushing" as determined above.

5. Insert threaded portion of the body of the bushing through the hole in the bulkhead.

6. Paint threads of bushing with petrolatum and zinc dust compound to prevent seizing after assembly and install the lock-nut on the bushing.

   Note: For wire mesh bulkheads, a metal washer is installed between the bulkhead and the lock-nut.

7. Tighten lock-nut with an end wrench.

Typical bushing installations for solid bulkheads and wire mesh bulkheads are shown in Figs. 2 and 3, respectively.

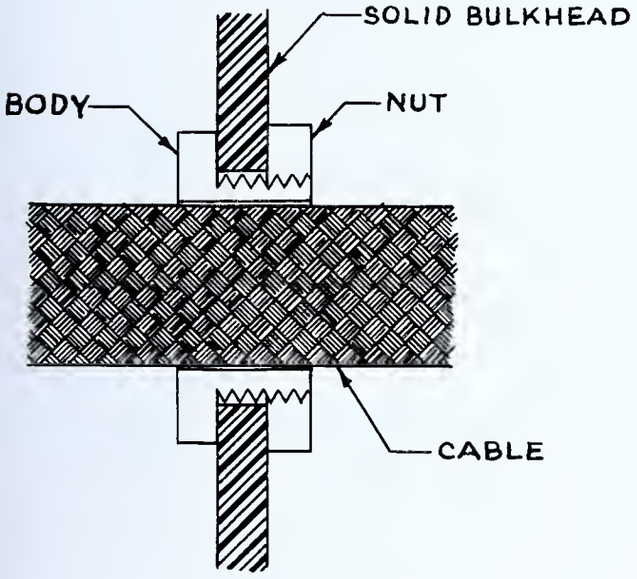


FIG.2

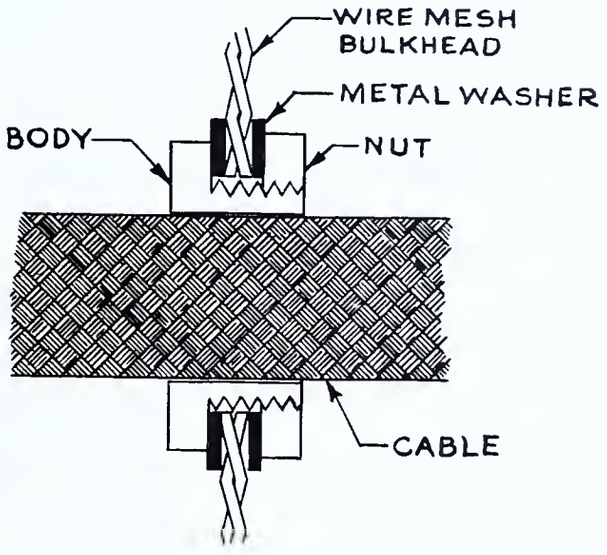


FIG. 3

TABLE I

ACTUAL C. M. AREA	STANDARD SIZE DESIGNATION	TYPE CABLE																									
		SLPP	SLPA	DLPP	DLPA	TLPP	TLPA	SFPP	SFPA	DFPP	DFPA	TFPP	TFPA	FFPP	FFPA	SHFA	DHFA	THFA	FHFA	FLP	FLA	SRLL	SRHLA	DRHLA	DRLL	TRHLA
2,828	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	C	C	-	-	-	-	-	-	-
4,494	4	A	A	D	D	D	E	A	B	D	E	E	F	E	G	B	E	F	G	G	G	A	K	T	C	T
9,030	9	C	C	G	G	J	J	B	C	E	F	F	G	-	-	D	F	G	-	-	-	-	-	-	-	-
14,350	14	C	C	J	J	J	J	C	C	G	G	G	J	-	-	D	G	J	-	-	-	-	-	-	-	-
22,820	23	D	D	K	K	K	K	C	C	G	J	J	J	-	-	D	J	J	-	-	-	-	-	-	-	-
30,780	30	D	D	K	K	L	L	C	D	J	K	K	K	-	-	E	K	K	-	-	-	-	-	-	-	-
38,950	40	D	E	L	L	M	M	C	D	K	K	K	L	-	-	E	K	L	-	-	-	-	-	-	-	-
49,020	50	E	E	M	M	M	M	C	D	K	L	L	M	-	-	F	L	M	-	-	-	-	-	-	-	-
59,940	60	F	F	M	M	N	N	D	D	M	M	M	N	-	-	F	M	N	-	-	-	-	-	-	-	-
75,850	75	G	G	N	N	P	P	D	E	M	N	N	P	-	-	G	N	P	-	-	-	-	-	-	-	-
98,820	100	G	G	P	P	R	R	E	F	N	P	P	R	-	-	G	P	R	-	-	-	-	-	-	-	-
125,050	125	J	J	R	R	R	R	E	G	P	R	R	R	-	-	J	R	R	-	-	-	-	-	-	-	-
157,380	150	J	J	S	S	S	S	F	G	S	S	S	T	-	-	J	S	T	-	-	-	-	-	-	-	-
198,860	200	J	K	S	T	T	T	G	J	S	T	T	T	-	-	J	T	T	-	-	-	-	-	-	-	-
250,710	250	K	K	T	T	V	V	-	-	T	V	V	-	-	-	-	V	W	-	-	-	-	-	-	-	-
296,660	300	L	L	W	W	X	X	J	J	V	W	X	X	-	-	K	W	X	-	-	-	-	-	-	-	-
414,020	400	M	M	X	Y	Z	Z	K	L	X	X	Y	Z	-	-	M	X	Z	-	-	-	-	-	-	-	-
521,970	500	N	N	-	-	-	-	L	M	-	-	-	-	-	-	M	-	-	-	-	-	-	-	-	-	-
657,860	650	P	P	-	-	-	-	M	M	-	-	-	-	-	-	N	-	-	-	-	-	-	-	-	-	-
829,310	800	R	R	-	-	-	-	N	N	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
1,046,000	1000	S	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,662,000	1500	V	V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE II

Standard Size Designation	Number of Conductors of Pairs	TYPE CABLE										
		GICP	GICA	GICF	MFPP	MFPA	MHFA	MCP	TPTP	TPTA	TTHFA	MCMB
1	1	-	-	-	-	-	-	-	-	A	B	-
2	2	C	C	B	C	D	D	-	-	-	-	-
3	3	-	-	-	-	-	-	-	B	B	C	-
4	4	E	E	-	D	E	E	B	-	-	-	-
5	5	-	-	-	-	-	-	C	C	D	C	-
7	7	F	G	C	E	G	G	C	-	-	-	D
10	10	J	J	E	J	J	J	D	E	E	D	-
12	12	-	-	-	-	-	-	D	-	-	-	-
14	14	J	J	G	J	K	K	-	-	-	-	-
15	15	-	-	-	-	-	-	-	E	F	D	-
19	19	K	K	L	K	L	L	-	-	-	-	-
20	20	-	-	-	-	-	-	-	F	G	E	-
22	22	M	M	M	L	M	M	-	-	-	-	-
25	25	-	-	-	-	-	-	-	G	G	F	-
26	26	M	M	N	M	N	N	-	-	-	-	-
30	30	M	M	N	M	N	N	-	G	G	G	-
37	37	N	N	N	N	P	P	-	-	-	-	-
40	40	-	-	-	-	-	-	-	J	J	G	-
44	44	P	P	R	R	R	R	-	-	-	-	-
50	50	-	-	-	-	-	-	-	J	J	J	-
60	60	-	-	-	-	-	-	-	K	K	K	-

Standard Size Designation	SCP	DCP	TCP
1	-	A	A
1 1/2	-	A	-
2	-	A	A
2 1/2	-	-	-
3	-	B	A
4	-	B	B
6	-	C	C
8	-	-	-
9	-	C	C
13	-	-	-
14	-	G	-
21	-	-	-
23	-	J	-
30	-	L	-
40	-	-	L
150	-	-	S
250	-	T	W
400	-	X	Z
650	-	-	-
800	S	-	-

APPLICATION OF BUSHINGS
TYPE IV (ALUMINUM)

Table III

SIZE BUSHING	DIA. HOLE FOR CABLE (inches)	HEX. NUT ACROSS FLATS (inches)	DIA. HOLE FOR BUSHING (inches)
A	0.406	15/16	23/32
B	0.515	1- 1/16	27/32
C	0.656	1- 3/16	31/32
D	0.750	1- 5/16	1- 3/32
E	0.812	1- 3/8	1- 5/32
F	0.859	1- 7/16	1- 7/32
G	0.968	1- 9/16	1-11/32
J	1.093	1-11/16	1-15/32
K	1.187	1- 3/4	1-17/32
L	1.281	1- 7/8	1-21/32
M	1.421	2	1-25/32
N	1.531	2- 1/8	1-29/32
P	1.640	2- 1/4	2- 1/32
R	1.796	2- 7/16	2- 7/32
S	1.937	2- 9/16	2-11/32
T	2.125	2- 3/4	2-17/32
V	2.250	2- 7/8	2-21/32
W	2.375	3	2-25/32
X	2.531	3- 3/16	2-31/32
Y	2.656	3- 5/16	3- 3/32
Z	2.812	3- 7/16	3- 7/32

Bushings shall be used for passage of single cables through N.W.T. bulkheads.

QUESTIONS

1. When and why are bushings installed?

2. (a) Under what condition can bushings be omitted in passing cable through a bulkhead or beam?
   (b) How is the hole prepared?

3. What information is necessary to spot a bushing on a bulkhead?

4. How are bushing locations marked on wire mesh bulkheads?

5. How are bushings installed in wire mesh bulkheads?

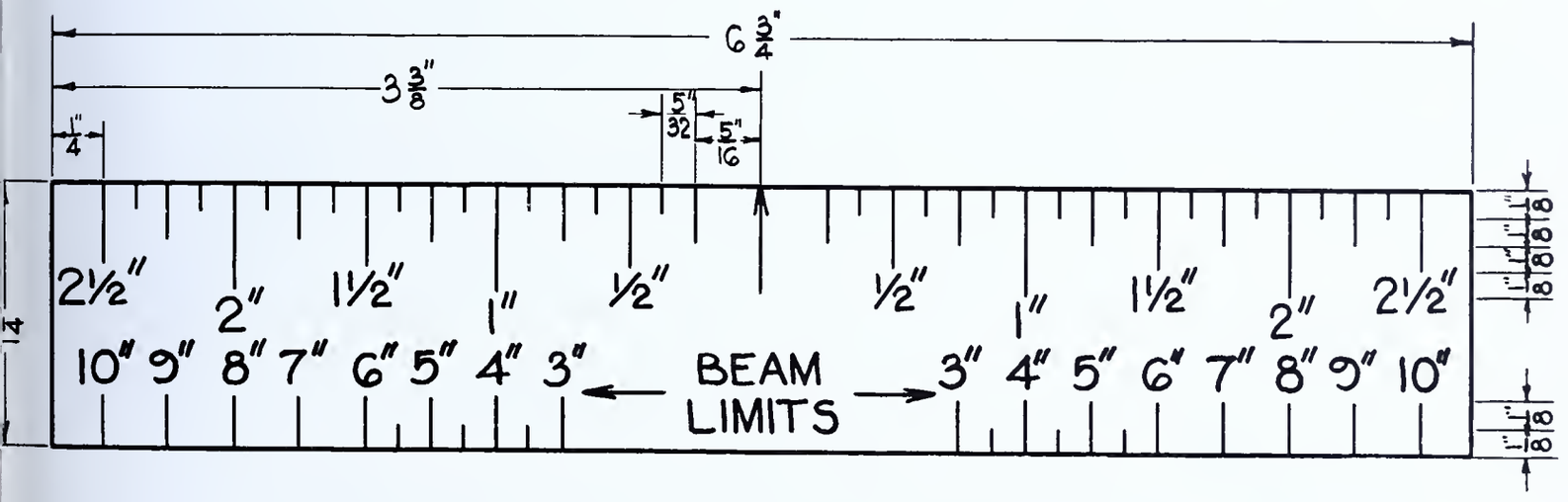
6. Why are bushings painted with a petrolatum and zinc dust compound before assembly?

THE "60-40" RULE FOR INSTALLING GROUPS OF STUFFING TUBES AND BUSHINGS

When stuffing tubes are installed adjacent to each other in decks or bulkheads, and bushings are installed adjacent to each other in bulkheads or beams, a certain percentage of metal must be maintained between drilled holes to prevent weakening of the structure of the deck, bulkhead or beam. The percentage of metal must be at least 60 percent of the distance between the centers of the drilled holes, regardless of the position with respect to each other (horizontally, vertically or on an angle). This leaves 40 per cent of the metal that may be removed; hence the "60-40" method.

To assist the electrician in speeding production and to reduce possibility of error, the "60-40" Rule was developed. See Fig. 1, Upper Scale.

In naval construction, the size of hole that may be drilled in a particular size beam is limited. The limiting sizes of holes for various sizes of beams have been conveniently added to the "60-40" Rule. See Fig. 1, Lower Scale.



"60-40" RULE

FIG. 1

Upper Scale:

The upper scale of the "60-40" Rule (Fig. 1) is graduated to give the desired distance between common sizes of holes.

The arrow mark in the center is designated as the "starting point" and on either side of the "starting point" hole diameters are indicated.

When two hole sizes are known, the center of the hole closest to the deck or bulkhead is determined and the deck, bulkhead or beam center punched. The hole size on one side of the "60-40" Rule is placed at the center punch mark, the size of the remaining hole is located on the opposite side of the "starting point" and the deck, bulkhead or beam center punched. This gives the desired spacing between the centers of the holes and the holes are then drilled.

Example:

Mark the required spacing between centers of two stuffing tubes to be installed on a line parallel to the deck, in the forward bulkhead of a compartment. The holes required for the stuffing tubes are 2" and 1" respectively and the 2" hole is to be drilled 5" from the adjoining port bulkhead and 5" from the overhead.

Procedure:

1. Spot and center punch location of 2" hole on the bulkhead.
2. Place "60-40" Rule against the bulkhead to be drilled, parallel to the deck.
3. Slide the rule along the bulkhead until the 2" point, on the left side of the "starting point", coincides with the center punch mark.
4. Locate the 1" mark on the right hand side of the "starting point" on the rule and mark this point on the bulkhead with chalk.
5. Center punch the bulkhead at the chalk mark.

Lower Scale:

The lower scale of the "60-40" Rule indicates the beam sizes by scribed lines. By projecting from any desired beam size on the lower scale to the corresponding point on the upper scale, the maximum hole size that may be drilled in that particular beam is determined.

Example:

What is the maximum size hole that may be drilled in a 9" beam?

Procedure:

1. Locate the 9" mark on either side of "BEAM LIMITS" on the lower scale.
2. Project this point to the upper scale, where the maximum hole diameter is indicated as 2-1/4".

PART V

INSTALLING CABLE LUGS, WIRE TERMINALS, EQUIPMENTS AND WIREWAYS

UNIT 17 — HOW TO INSTALL VARIOUS TYPES OF SOLDERED AND SOLDERLESS TYPE LUGS AND WIRE TERMINALS — Page 104

UNIT 18 — PAD HOLDERS — Page 119

UNIT 19 — RECOMMENDED HEIGHTS FOR FIXTURES, FITTINGS, AND APPLIANCES — Page 120

UNIT 20 — METHODS OF SECURING FIXTURES, FITTINGS AND APPLIANCES TO WATERTIGHT AND NON-WATERTIGHT DECKS, BULKHEADS, etc. — Page 122

UNIT 21 — METHODS OF SUPPORTING CABLES TO VARIOUS TYPE DECKS AND BULKHEADS USING STRAPS AND HANGERS — Page 191

HOW TO INSTALL VARIOUS TYPES OF SOLDER AND SOLDERLESS TYPE LUGS AND WIRE TERMINALS

General Information:

The practice of splicing conductors is not permitted on Naval vessels because a positive connection is not insured; therefore, lugs or wire terminals are used to make positive connections wherever conductors terminate.

Either approved solder or solderless type lugs or terminals are used, depending upon the job specifications and the type of installation desired; however, solderless lugs are used on all heat- and flame-proof types of cable where space requirements permit their use.

Where fixtures or fittings are provided with clamp type fittings or terminal posts with staked securing screws, the installation of lugs or terminals is not practicable and the conductor must be prepared as noted herein before being placed under the securing screw.

Numerous types of connection boxes, switchboards and panels are provided with lugs or terminals of the one-bolt hole or two-bolt hole types. Two-bolt hole type lugs or terminals are used in larger connection boxes and on switchboard bus work where installation requirements do not permit lugs or terminals to turn. Such turning might cause possible contact with other lugs or terminals. One-bolt hole lugs or terminals are used on equipments and boxes where contact of lugs with one another is not probable.

Larger type lugs are usually furnished with their contact surfaces tinned or silver plated according to their use, for example:

(a) Lugs for 4,000 C. M. to 60,000 C. M. cable used on copper bus bars not having silvered contacts are furnished with tinned contact surfaces.

(b) Lugs for 4,000 C. M. to 60,000 C. M. cable used on copper bus bars having silvered contacts are furnished with silver-plated contact surfaces.

(c) Lugs for 75,000 C. M. to 400,000 C. M. cable used on copper bus bars (both copper contacts and silver contacts) are furnished with silver-plated contact surfaces.

Materials:

Solder flux	Solder type lugs	) various
Solder, 50-50	Solderless type lugs	) types
Solder, core type	Solder type wire terminals	) and
	Solderless type wire terminals	) sizes

Cable (assorted types with solid and stranded conductors)

Tools:

Electrician's blow torch	Squeeze-on tool
Electric soldering iron	Stak-on tool
Electric lug heating pliers	Knife
Hack saw	10" crescent wrench
Hammer	Gas pliers
	Allen set screw wrenches
	Screw driver

Equipment:

Plumber's furnace with solder pot and ladle
Plumber's blow torch

Uses of various tools, equipments and materials for installation of lugs are described below.

(a) Plumber's furnace, solder pot and ladle are used for installation of large solder type lugs, when working space is not confined.

(b) Plumber's blow torch is used for installation of large solder type lugs, when working space is confined.

(c) Electrician's blow torch is used for installation of small solder type lugs, when working space is confined.

(d) Electric soldering iron and lug heating pliers are used for installation of small solder type lugs and terminals when working space is not confined.

(e) Squeeze-on and "stak-on" tools are used for installation of solderless lugs on small conductors.

(f) Core type solder is used when installing small solder type lugs.

HOW TO SELECT THE PROPER SIZE LUG OR WIRE TERMINAL

Lugs:

Table I is for use with Navy type cables and is derived from Bureau of Ships drawings 9-S-3808-L, 9-S-4435-L and 9-S-4795-L as indicated thereon.

Lugs are built up assemblies, castings or punched tubing having sufficient metal to permit the carrying of nominal current ratings of the cable on which they are installed. The nominal current rating is usually stamped on the lugs by leading manufacturers, although the hole for the conductor is predetermined for a particular circular mil area cable. In view of this practice, the electrician should determine from Table I the nominal current rating lug required for a given circular mil area cable. The type of lug, whether one-bolt hole or two-bolt hole, solder or solderless, is determined by the electrician from the nature of the installation (see General Information). When the type of lug and the nominal current rating is known, the electrician may order the desired lug from stock.

Wire Terminals:

Wire terminals are made of thin copper strips and are designed for low current carrying capacity (both solder and solderless type) installations. Unlike lugs, the size of the terminal is determined by the circular mil area cable on which it is installed. Therefore, when the type of terminal (solder or solderless, one-bolt hole or two-bolt hole) and the circular mil area of the conductor is determined by the electrician, the terminal may be ordered from stock.

TO INSTALL VARIOUS SOLDER TYPE LUGS AND WIRE TERMINALS

Soldered Type Lugs (Punched Tube and Cast Types)

1. Determine from Table I the proper size and type lug to be installed and obtain lug from stock.

2. Remove the insulation from the conductor for a distance equal to the depth of the hole in the lug. (See Fig. 1.)

3. Clean each strand at the bared conductor thoroughly by scraping with a knife.

4. Tin the strands of the bared conductor for the full length.

FIG. 1

5. Clean the inside of the lug with sandpaper or by scraping with a knife. Soldering salt or other soluble cleaning agents may be used.

6. Tin the inside of the lug, holding the lug with pliers.

7. Continue to heat the lug and fill the lug with molten solder. See Fig. 2.

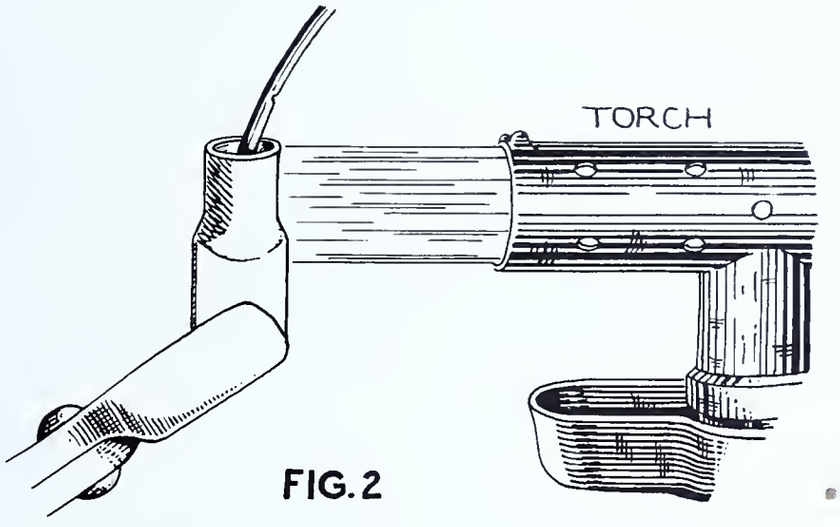


FIG.2

8. While continuing to heat the lug, insert the bared conductor into the hole in the lug for the full length. See Fig. 3.

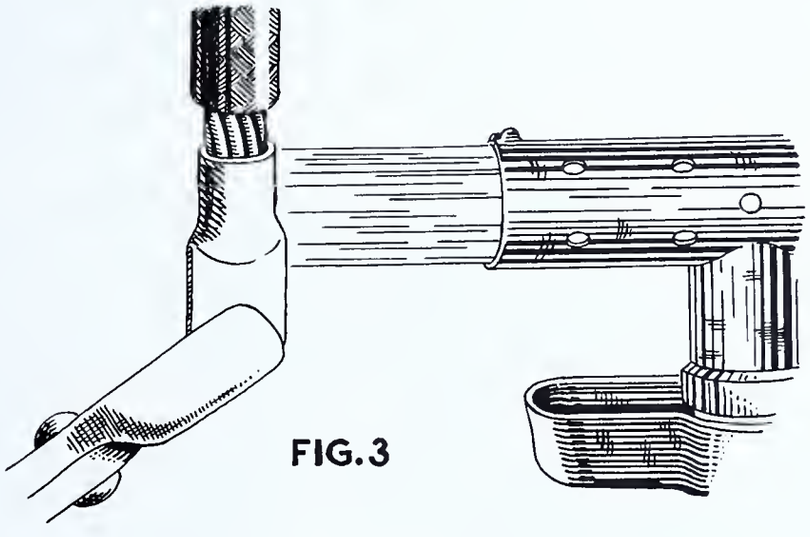


FIG.3

Note: The conductor should be inserted slowly into the hole in the lug, to permit the solder to thoroughly work into the spaces between the stranded wires. During this operation a certain amount of the solder will be drawn into the space between the conductor strands behind the insulation. This action necessitates the refilling of the lug with solder.

9. Allow lug to cool.

Note: After cooling, if shrinkage of solder is too great the lug should be reheated and refilled with solder.

SOLDERED TYPE WIRE TERMINALS

1. Determine the proper size and type to be installed and obtain terminal from stock.

2. Remove the insulation from the conductor for a distance equal to the length of the trough in the terminal. See Fig. 4.

3. Clean the bared conductor thoroughly by scraping with a knife.

4. Tin the bared conductor for the full length.

FIG. 4

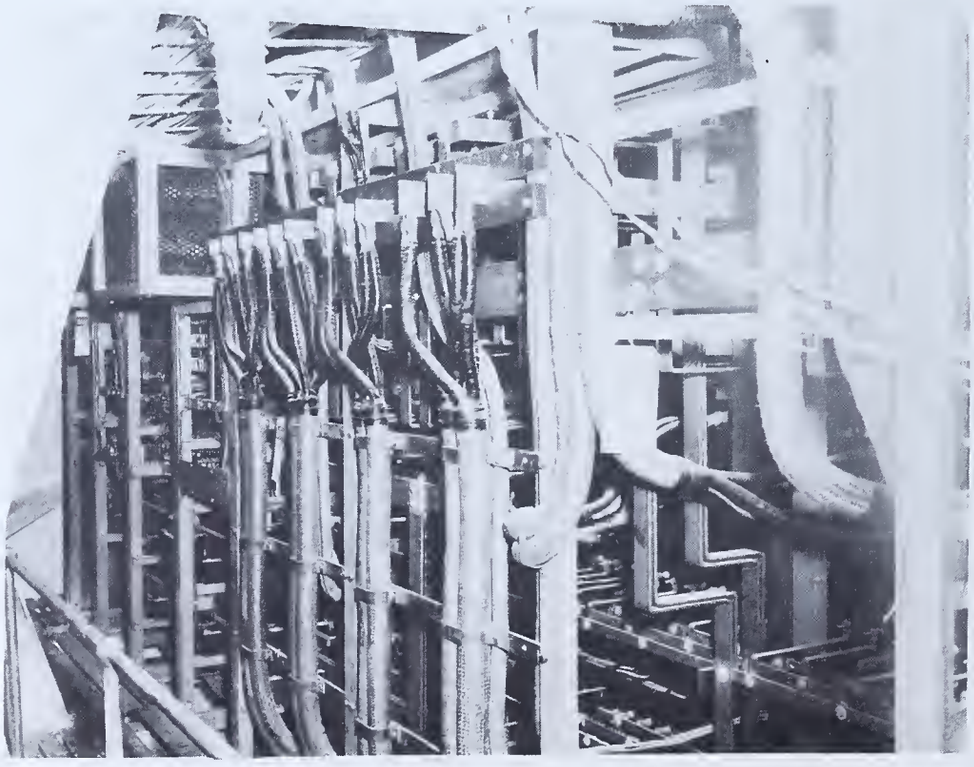
5. Insert the bared conductor into the trough for the full length and crimp the trough over the conductor, using diagonal pliers. See Fig. 5.

6. Apply flux to the trough of the terminal.

FIG. 5

7. Apply heat to the terminal and conductor and fill the trough with solder until the conductor is completely covered, using a small blow torch or soldering iron.

Note: When the terminal and conductor are heated to the proper temperature, the solder will flow freely, fill in the space between the strands of the conductor and between the conductor and the terminal, thereby making a good electrical connection.



TO INSTALL VARIOUS SOLDERLESS TYPE WIRE TERMINALS AND LUGS

Solderless Type Wire Terminals (Squeeze-on)

1. Determine the proper size and type terminal to be installed and obtain terminal from stock.

2. Remove the insulation from the conductor for a distance equal to the depth of the hole in the terminal. See Fig. 6.

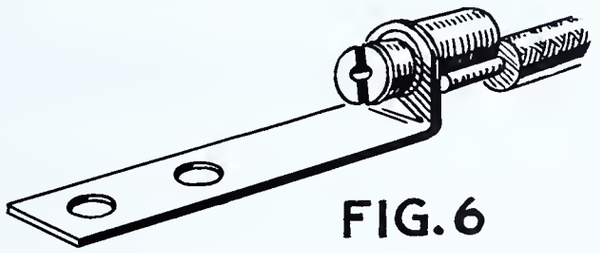


FIG. 6

3. Clean the bared conductor thoroughly by scraping with a knife.

4. Insert the bared conductor into the hole in the terminal until the insulation butts the terminal.

5. Select the proper squeeze-on tool for the specific wire size. See Fig. 7.

FIG. 7

6. Place the conductor and the terminal into the opening (Step 5) as shown in Fig. 7.

7. Squeeze the tool together, being careful to keep the terminal straight and the insulation of the conductor tight against the terminal. See Fig. 8.

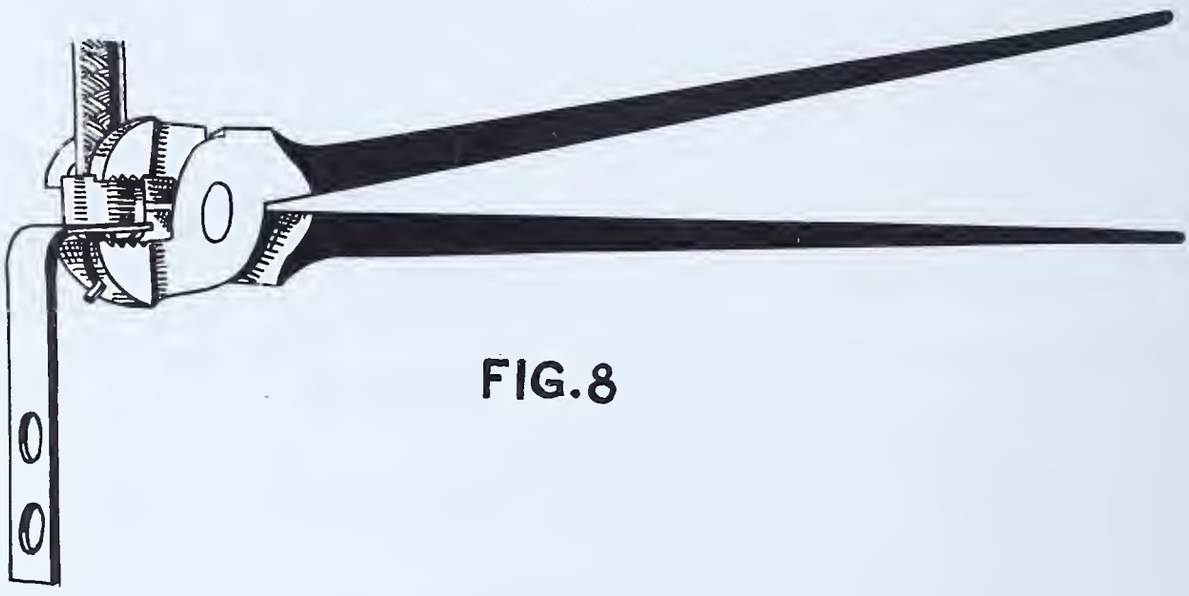


FIG. 8

SOLDERLESS TYPE WIRE TERMINALS (STAK-ON)

1. Determine the proper size and type terminal to be installed and obtain terminal from stock.

2. Remove the insulation from the conductor for a distance equal to the depth of the hole in the terminal. See Fig. 9.

FIG. 9

3. Clean the bared conductor thoroughly by scraping with a knife.

4. Insert the bared conductor into the hole in terminal until the insulation butts the terminal.

5. Select the proper nick in the stak-on tool for the terminal being installed. See Fig. 10.

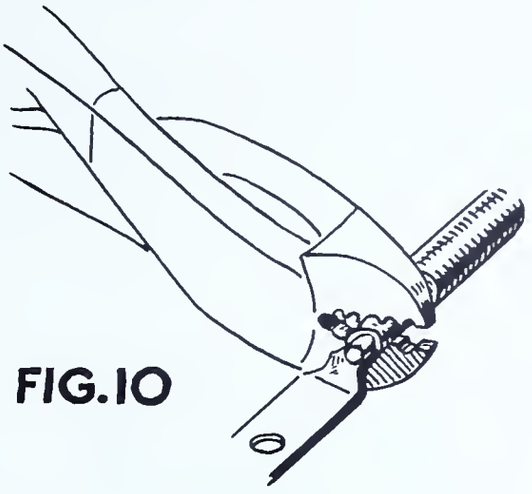


FIG.10

6. Place the terminal in the nick (Step 5) and squeeze stak-on tool until the terminal firmly grips the conductor. See Fig. 10.

   Note: During this step, the electrician must be careful to keep the terminal straight and the bared conductor completely inserted into the terminal.

SOLDERLESS TYPE LUGS (CAST) (CLOSED END)

Note: This type of lug is of commercial manufacture and has been approved by the U. S. Navy for installation on Naval vessels. Table I may be used for obtaining nominal current rating for this type of lug.

1. Determine the type (one-bolt hole or two-bolt hole) of the lug required and obtain the corresponding nominal current rating. Obtain lug from stock.

2. Remove the insulation from the conductor for a distance equal to the length of the ferrule. See Fig. 11.

3. Clean the bared conductor thoroughly by scraping with a knife.

FIG.11

4. Install jam nut of the lug over the bared conductor (the threaded portion toward the end of the conductor) and hold firmly against the insulation. See Fig. 12.

5. Install the ferrule over the conductor (smaller end of the taper toward the end of the conductor) and slide it into the jam nut. See Fig. 12.

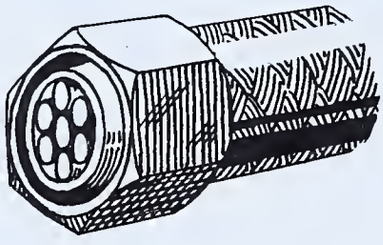


FIG.12

6. Install the lug over the conductor and insert the threaded end into the jam nut.

7. Holding the jam nut firmly against the insulation, tighten the jam nut until the conductor is held securely. See Fig. 13.

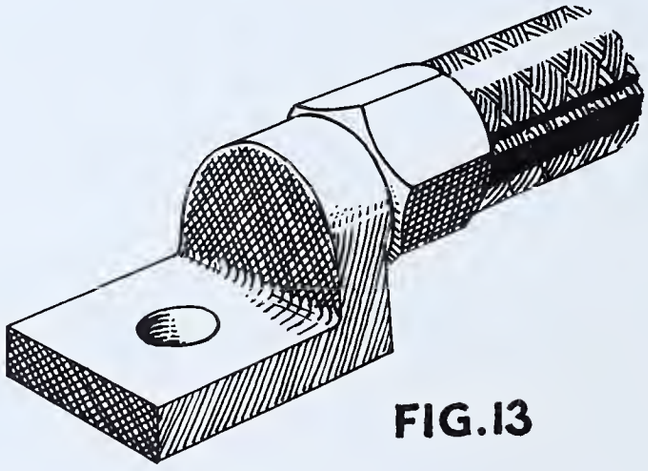


FIG.13

Note: After each turn on the jam nut, the lug should be tapped on the end, to keep the jam nut tight against the insulation of the conductor.

SOLDERLESS TYPE LUGS (CAST) (OPEN END)

Note: The note listed under solderless type, cast and closed end lugs also applies to this type of lug; therefore, Table I may be used for nominal current ratings of lugs.

1. Determine the type (one-bolt hole or two-bolt hole) of the lug required and from Table I obtain the corresponding nominal current rating. Obtain lug from the stock.

2. Remove the insulation from the conductor for a distance equal to the combined lengths of the jam nut and the ferrule. See Fig. 14.

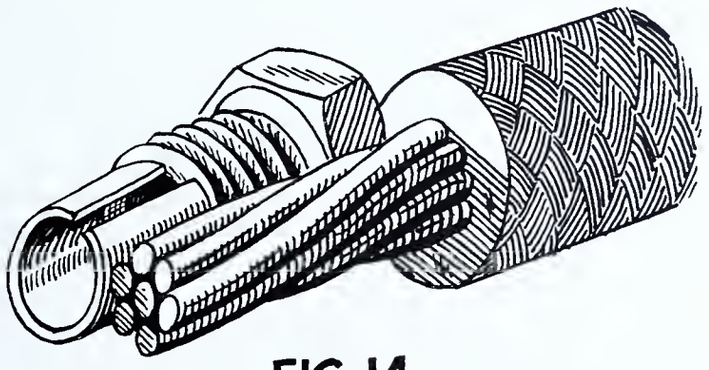


FIG.14

3. Clean the bared conductor thoroughly by scraping with a knife.

4. Install jam nut of the lug over the bared conductor (the threaded portion toward the end of the conductor) and hold firmly against the insulation.

5. Install the ferrule over the conductor (smaller end of the taper toward the end of the conductor) and butt firmly against the jam nut.

6. Install the lug over the conductor, the ferrule and the jam nut.

Note: To start the first thread it may be necessary to hit the end of the lug a sharp rap with a hammer. See Fig. 15.

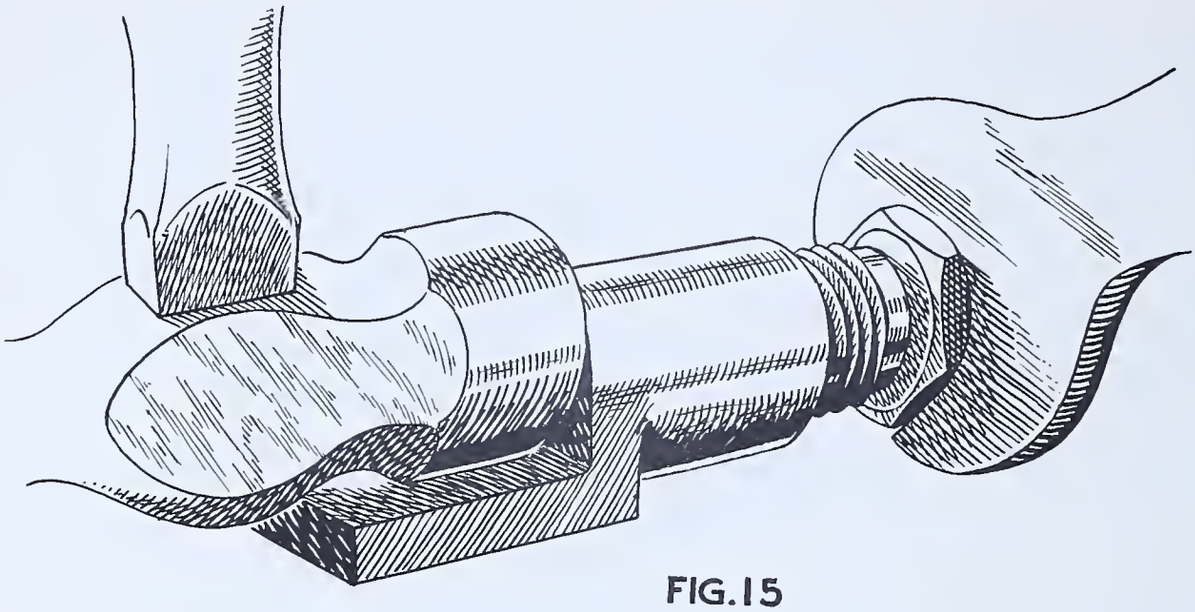


FIG. 15

7. Hold the jam nut firmly against the insulation and tighten the jam nut until the conductor is held securely.

   Note: After each turn on the jam nut, the lug should be tapped on the end, to keep the jam nut tight against the insulation of the conductor. See Fig. 15.

8. Cut the protruding end of the bared conductor flush with the open end of the lug, using a hack saw. The completed installation should have the appearance of Fig. 16.

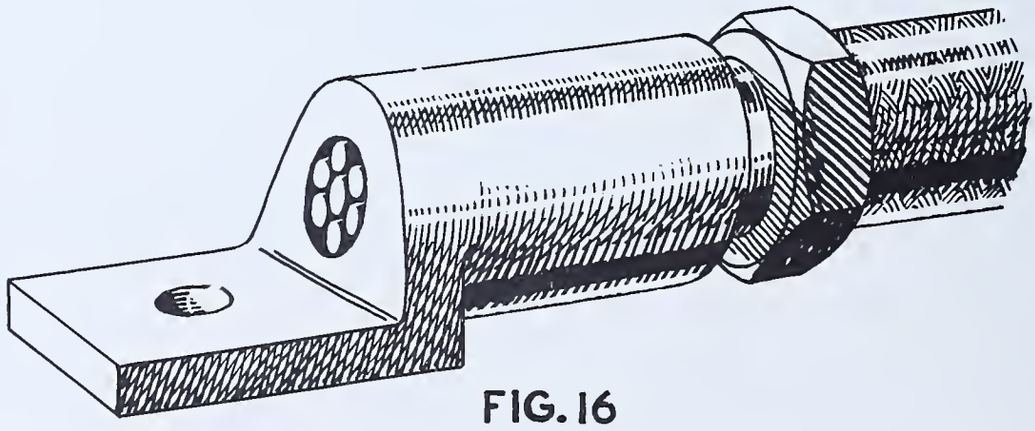


FIG. 16

Note: When this type of lug is installed, the bared conductor should extend through the lug so that the conductor is flush with the open end of the lug, to insure good electrical connection.

SOLDERLESS TYPE LUGS (CLAMP)

1. Determine from Table I the proper size and type lug to be installed and obtain lug from stock.

2. Remove the insulation from the conductor for a distance equal to the length of the hole in the lug. See Fig. 17.

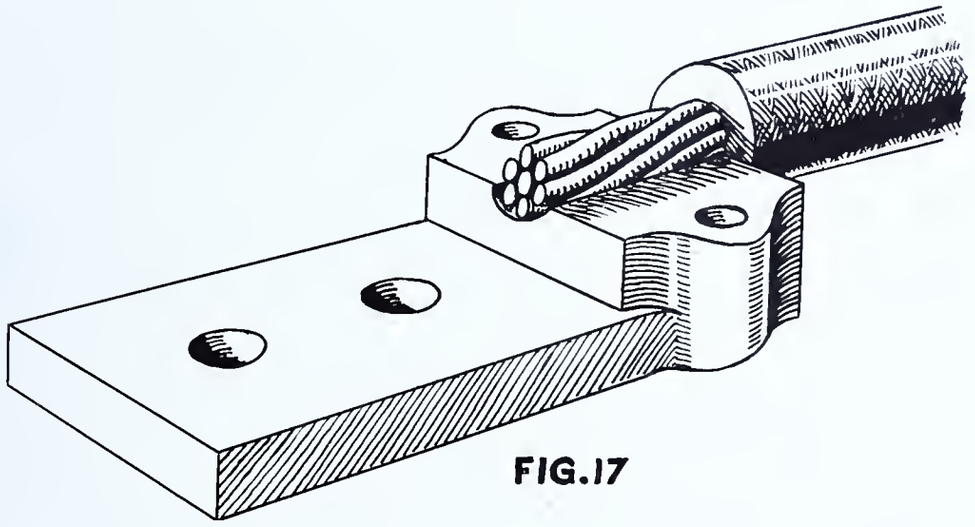


FIG.17

3. Clean the bared conductor thoroughly by scraping with a knife.

4. Insert the bared conductor into the hole in the lug until the insulation butts the lug.

5. Tighten the clamping screws with a crescent wrench, screw driver or Allen set screw wrench, depending on type of clamping screws supplied, until the conductor is firmly secured in the lug. See Fig. 18.

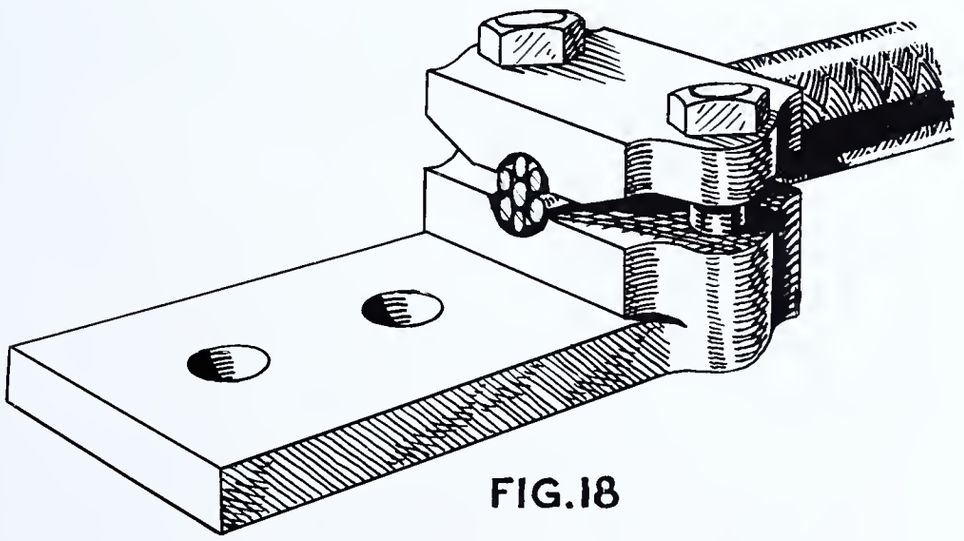


FIG.18

HOW TO TERMINATE CONDUCTORS WHERE INSTALLATION OF LUGS IS NOT PRACTICABLE

A. WHERE SECURING SCREW IS REMOVABLE:

1. Remove the insulation from the cable for a distance that will permit forming an eye to fit over the securing screw.
2. Clean the bared conductor thoroughly by scraping with a knife.
3. Twist the strands of the conductor tightly together.
4. Bend bared conductor around a mandrel and form an eye to fit over the securing screw. See Fig. 19.
5. Dip the eye (Step 4) into molten solder.

   Note: Step 5 should be repeated until the solder fills between the strands of the conductor, giving the appearance of a solid wire. See Fig. 19. Outside of the shop, a soldering iron or torch and solder may be used instead of dipping.
6. Allow solder to cool.
7. Insert securing screw through the eye (Step 5) and into the tapped hole. Tighten the securing screw.

FIG. 19

B. WHERE SECURING SCREW IS NOT REMOVABLE:

1. Remove the insulation from the cable for a distance that will permit wrapping the conductor once around the securing screw.
2. Clean the bared conductor thoroughly by scraping with a knife.
3. Twist the strands of the conductor tightly together.
4. Dip the bared conductor into molten solder.

   Note: Step 4 should be repeated until the solder fills between the strands of the conductor, giving somewhat the appearance of a solid wire. See Fig. 20. Outside of shop, a soldering iron or torch and solder may be used instead of dipping.

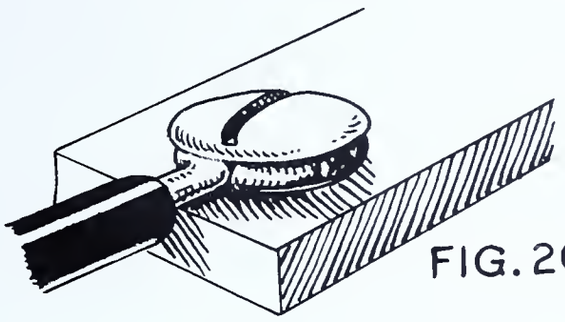


FIG. 20

5. Wrap the soldered end of the conductor (Step 4) around the securing screw. Tighten the securing screw.

C. WHERE SECURING SCREWS ARE OF THE CLAMP TYPE:

1. Remove the insulation from the cable for a distance that is equal to the length of the hole in the securing clamp. See Fig. 21.

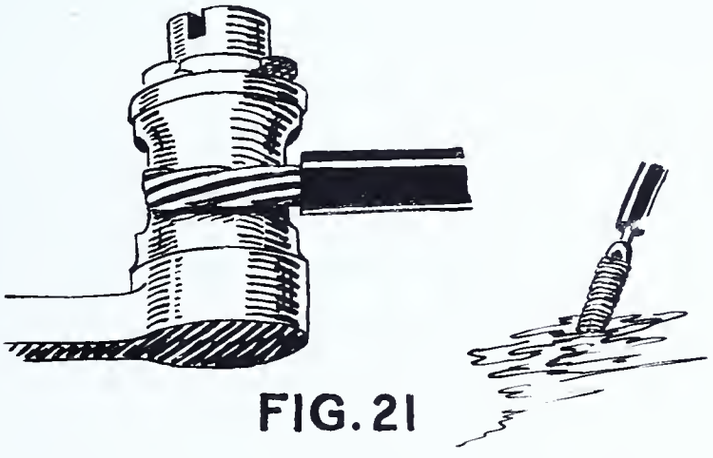


FIG. 21

2. Clean the bared conductor thoroughly by scraping with a knife.

3. Twist the strands of the conductor tightly together.

Note: Where conductor is small (either stranded or solid) the conductor is bared for at least twice the length determined in Step 1, bent back upon itself and served with a strand of fine wire. See Fig. 21.

4. Dip the bared conductor into molten solder.

Note: Step 4 should be repeated until the solder fills between the strands of the conductor and the wrapping (Step 3), giving the appearance of a solid wire.

Outside of shop, a soldering iron or torch and solder may be used instead of dipping.

5. Insert conductor into the hole in securing clamp until insulation butts the clamp. Tighten the securing screw.

TABLE I

CABLE SIZE IN C. M.	OUTSIDE DIAMETER OF BARED CONDUCTOR (inches)	NOMINAL RATING OF LUGS (amps.)	DIAMETER OF HOLE IN LUG FOR CONDUCTOR (inches)		
			PUNCHED TUBE TYPE 9-S-3808-L	CAST TYPE 9-S-4435-L	CLAMP TYPE 9-S-4795-L
4000	.076	25	.136	.137	
9000	.108	35	.187	.187	
14000	.136	50	.232	.187	
23000	.171			.250	
30000	.201	70	.285	.250	
40000	.226			.281	
50000	.254	90	.336	.312	
60000	.282	125	.398	.343	
75000	.317	150	.461	.375	11/32
100000	.363	175	.511	.437	3/8
125000	.407	225	.559	.500	7/16
150000	.457	235	.651	.562	15/32
200000	.514	325	.776	.625	17/32
250000	.577			.687	19/32
300000	.628	360	.820	.750	21/32
400000	.742	400	.881	.875	3/4
500000	.833	450	.944	.968	
650000	.938	550	1.084	1.094	
800000	1.051	650	1.210	1.218	

LUGS
PUNCHED TUBE TYPE (SOLDER TYPE) (ONE-BOLT HOLE) 9-S-3808-L
CAST TYPE (SOLDER TYPE) (TWO-BOLT HOLES) 9-S-4435-L
CLAMP TYPE (SOLDERLESS) (TWO-BOLT HOLES) 9-S-4795-L

PAD HOLDERS

Pads are installed on brackets, decks and bulkheads for the support of fixtures, fittings and cables.

To speed the installation of pads and provide convenient means of holding the pads while they are being tack-welded, various types of pad holders have been developed. The most commonly used pad holder is shown in Fig. 1.

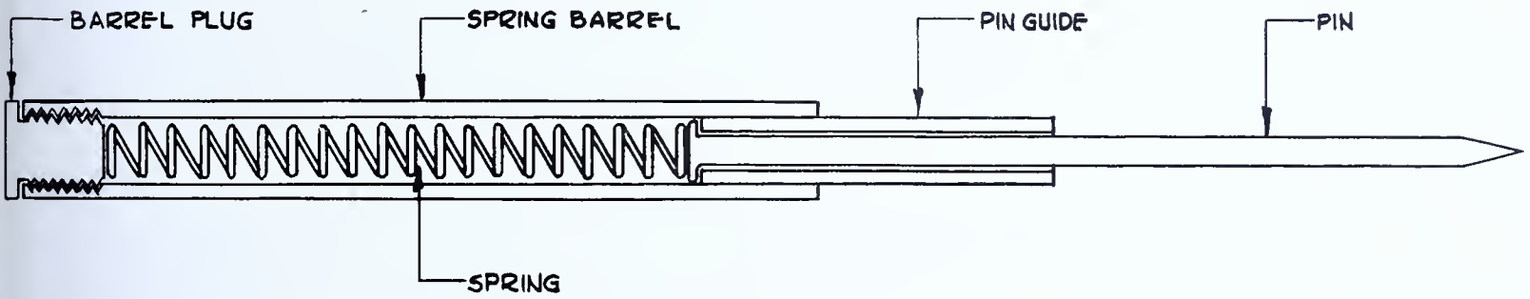


FIG. 1

After the pad locations have been determined and center punched, the pad holder is used as shown in Fig. 3 (the point of the pin being inserted into the center punch).

FIG. 2

RECOMMENDED HEIGHTS FOR FIXTURES, FITTINGS AND APPLIANCES

The following recommended heights are accepted where single equipments are installed on a bulkhead, etc., or wherever space or installation conditions permit.

When a group of equipments is to be installed in the same general vicinity, the limits set forth in general information of Unit 20 shall prevail.

Name of Equipment	Recommended Installed Height
Annunciator	6'-0" from deck to top of annunciator
Berth Fixture	3'-3" from bottom of berth to center of fixture
Blinker Light Controller	3'-3" from deck to bottom of controller
Branch Box (Bulkhead Mounted)	5'-6" to 7'-0" from deck to top of box
Bulkhead Fixture (Blue or Red Globe)	2'-0" from deck to bottom of fixture
Bulkhead Fixture (White Globe)	5'-6" from deck to bottom of fixture
Ceiling Fixture	6'-6" from deck to bottom of shade
Chart Board Light	1'-6" from top of chart board to bottom of reflector
Connection Box (Bulkhead Mounted)	5'-6" to 7'-0" from deck to top of box
Contact Maker (Lever Operated)	5'-0" from deck to top of contact maker
Contact Maker (Push-button Operated)	5'-0" from deck to top of contact maker
Controller for Motor	5'-6" to 7'-0" from deck to top of controller
Deck Fixture	6'-6" from deck to bottom of reflector
Desk Light	1'-6" from top of desk to bottom of reflector
Distribution Box (Bulkhead Mounted)	5'-6" to 7'-0" from deck to top of box
Fan, Bracket	6'-6" above deck to center of base
Floodlight (500 Watt)	5'-0" from deck to center of light
Hand Lantern	5'-0" from deck to center of supporting bracket
Jack Box, Telephone	3'-0" from deck to center of box
Junction Box, (Bulkhead Mounted)	6'-0" to 7'-0" from deck to top of box
Lighting Distribution Panel	5'-6" to 7'-0" from deck to top of panel
Locker, Stowage, Telephone, Sound Powered	1'-8" above deck to bottom of locker

Magazine Fixture	7'-0" from deck to bottom of fixture
Portables	5'-0" from deck to center of supporting bracket
Power Distribution Panel	5'-6" to 7'-0" from deck to top of panel
Pulsator	2'-0" from deck to bottom of pulsator
Pushbutton (Bulkhead Mounted)	4'-0" from deck to center of pushbutton
Pushbutton (Pear Type)	2'-6" from top of table to bottom of pushbutton
Receptacle	4'-6" from deck to center of receptacle
Running, Anchor and Signal Lights	As specified for the vessel concerned
Searchlight, 12"	5'-8" from deck to center of light
Shaving Light	Directly above mirror
Shore Terminal Box	5'-0" from deck to bottom of box
Supply Panel for Running, Anchor and Signal Lights	4'-6" from deck to bottom of panel
Switch Box, Telephone, Sound Powered	6'-0" from deck to top of box
Switch, Door Operated	Top of door - open side
Switch, Rotary Selective (Bulkhead Mounted)	2'-6" from deck to top of enclosing case
Switch, Snap	4'-6" from deck to center of switch
Switch and Receptacle	4'-6" from deck to center of receptacle
Tell-Tale Panel for Running Lights	4'-6" from deck to bottom of panel
Transfer Panel	6'-0" to 7'-0" from deck to top of panel
Truck and Screened Speed Light Controller	5'-0" from deck to center of controller

METHODS OF SECURING FIXTURES, FITTINGS AND APPLIANCES TO WATERTIGHT AND NON-WATERTIGHT DECKS, BULKHEADS, ETC.

General Information:

The following methods are derived from U. S. Navy Bureau of Ships drawing 9-S-3980-L and indicate mountings for molded phenolic and cast steel and aluminum fixtures, fittings and appliances.

Recent developments are rapidly changing the enclosing cases of fixtures, fittings, and appliances from the above mentioned types to sheet steel enclosures; however, methods of mounting remain unchanged from those indicated herein.

The following directions apply to all methods listed herein and should be thoroughly memorized by the trainee:

A. When electrical fittings of aluminum alloys are mounted on steel or aluminum decks, bulkheads or other surfaces of dissimilar metal, the faying surfaces shall be painted with one coat of zinc chromate primer and there shall be inserted between the faying surfaces either a canvas or flannel gasket or washer impregnated with zinc chromate primer.

B. Electrical fittings of molded phenolic material, when mounted on steel or aluminum decks or bulkheads, shall have between the faying surfaces a canvas or flannel gasket or washer impregnated with spar varnish of the phenolic type.

C. Where molded phenolic fittings or fixtures are secured to decks, bulkheads, plates, hangers, etc., a leather washer, 1/16" thick, impregnated in oil, shall be placed against the molded phenolic composition followed by a steel washer underneath the head of the securing screw (see Method EE, Page 125) to prevent cracking the phenolic material when tightening the securing screw.

D. Shakeproof washers shall be installed under the heads of all securing bolts for lighting fixtures, bells, buzzers, indicators, control panels, etc.

E. All motor controllers, distribution panels and similar apparatus shall be installed at a height so that either the bottoms of the enclosing cabinets shall not be less than 5 ft. or tops not more than 7 ft. above the deck. In cases where more than one appliance is involved and it is not practicable to mount them alongside each other, they may be mounted one above the other provided that the top of the uppermost appliance is not more than 7 ft. above the deck and the bottom of the lower appliance not less than 14" above the deck.

F. All hand operated appliances, including distribution boxes with switches, receptacles, pushbuttons, jack boxes and other similar appliances, shall be installed on bulkheads at a height of not more than 6 feet above the deck. See Unit 19.

G. Connection boxes, feeder connection boxes, feeder distribution boxes, feeder junction boxes and distribution boxes without switches may be installed on the overhead provided the deck height does not exceed 9 feet and the minimum head room under the appliance is not less than 7 feet, provided such installation in all cases is satisfactory to the ship's inspector.

H. All controllers, panels and apparatus shall be so installed that they are completely accessible for operation, repairs, renewal of fuses, testing, etc.

I. In storerooms, issuing rooms, commissary spaces, etc., particular attention shall be given to the location of lighting fixtures in order that these fixtures will be in the center of aisle space and not above bins, fittings, and equipage.

J. Unless otherwise indicated on approved plans and insofar as practicable, all rotor shafts shall be mounted in a fore and aft position and all controllers shall be mounted athwartship.

K. In selecting material for any hanger or support, the electrician should first try to obtain the required material from the scrap pile, in the interest of economy. If the required size is not obtainable in the scrap pile it should be cut from stock material.

The following are necessary tools, equipment and materials for installation of fixtures, fittings, and appliances:

Tools:

Drills (various sizes)
Pipe taps and wrenches (various sizes)
Machine taps and wrenches (various sizes)
Screw driver
Hammer, ball peen
Cable clamp tool
Pad holder
Center punch
End wrenches (various sizes)
10" pipe wrench
Square
Hack saw
Files
12" metal rule
6' folding rule
Scribe
Rivet set
Compasses

Equipment:

Bench drill
Vise
Bench shears
Emery wheel
Hand operated brake
Bench clamps

Materials:

Hexagon head bolts, steel (various sizes)
Hexagon nuts (various sizes)
Round head machine screws (various sizes)
Flat washers, steel (various sizes)
Lock washers, steel (various sizes)
Shakeproof washers, steel (various sizes)
1/16" leather washers (various sizes)
Canvas (heavy)
Canton flannel
Pads, steel (various sizes tapped as required
Stud pads, steel (various sizes)
Stools, steel (various sizes)
3/8" aluminum rivets (round head)
3/8" aluminum rivets (flat head)
Zinc chromate primer
Spar varnish
Shellac
Red lead
Chalk
Crayon, yellow
3/4" close pipe nipple
Galvanized pipe (3/4", 1", 1½", 2")
Terminal tubes (various sizes)
Cable clamps (various sizes)
Strap, steel (various thicknesses)
Strap, aluminum (various thicknesses)
Sheet steel (various thicknesses)
Sheet aluminum (various thicknesses)
1/16" sheet asbestos
Various types of fixtures, fittings and appliances

Associated Trades:

Shipfitter

Welder

Driller

Sheet Metal Worker

METHOD EE

METHOD OF SECURING FIXTURE OR FITTING

TO STEEL DECK OR BULKHEAD -- W. T.

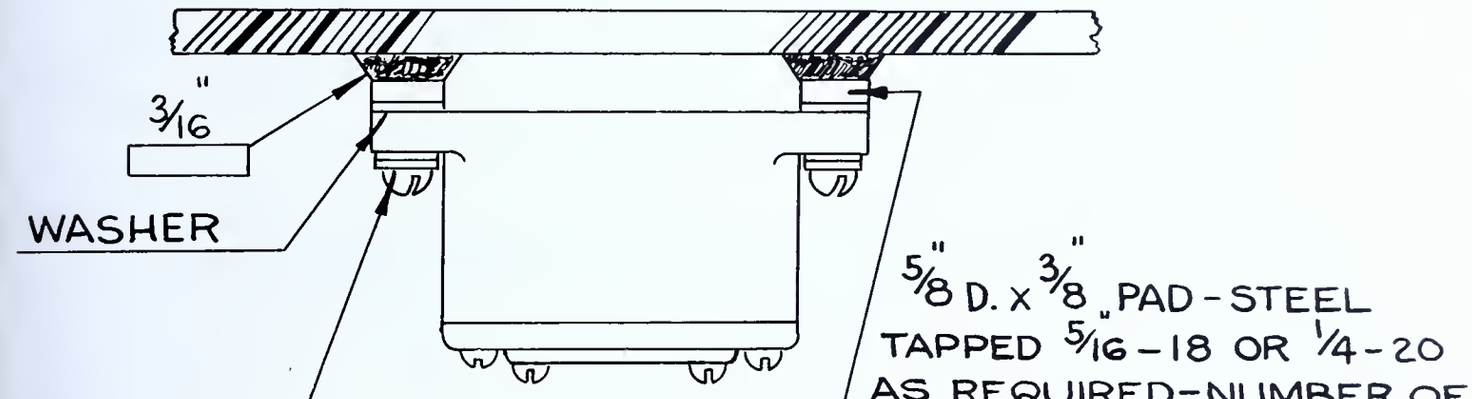


FIG. - 1

1. Determine number of mounting holes in fixture or fitting to be mounted.

2. Draw from stock, 5/8" D. x 3/8" steel pads with drilled and tapped holes to suit machine screws intended to support the fixture or fitting. The number of pads required was determined in Step 1.

   Note: The size of the screw is determined by the drilled holes in the mounting feet or the base of the fixture or fitting to be mounted.

3. Install suitable round head machine screws through the mounting holes in the fixture or fitting and into the tapped hole of the pads.

4. Hold fixture or fitting in the desired location on the deck or bulkhead and have welder tack-weld pads to the deck or bulkhead. See Fig. 1.

5. Remove machine screws and fixture or fitting from pads and have welder fillet-weld pads all around as shown in Fig. 1.

6. Remount the fixture on the pads and spot locations at which cables are to penetrate fixture or fitting and mark with chalk or crayon.

7. Remove fixture from pads and have holes drilled for terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

8. Paint surface of pad and bottom of fixture (where pad is to butt) with one coat of zinc chromate primer.

9. Cut canvas or canton flannel washers using the pads as templates.

10. Impregnate washers with zinc chromate primer.

    Note: Where material is to be left bright or where fixture or fitting is of the molded phenolic type, the washer and the contact surface (Step 8) are painted with spar varnish of the phenolic type.

11. Insert washers between fixture or fitting and pads. See Fig. 1.

12. Insert round head machine screws through the mounting holes of the fixture or fitting, through the washers and into the pads.

13. Tighten screws with a screw driver.

METHOD FF

METHOD OF SECURING FIXTURE OR FITTING

TO STEEL N. W. T. BULKHEAD

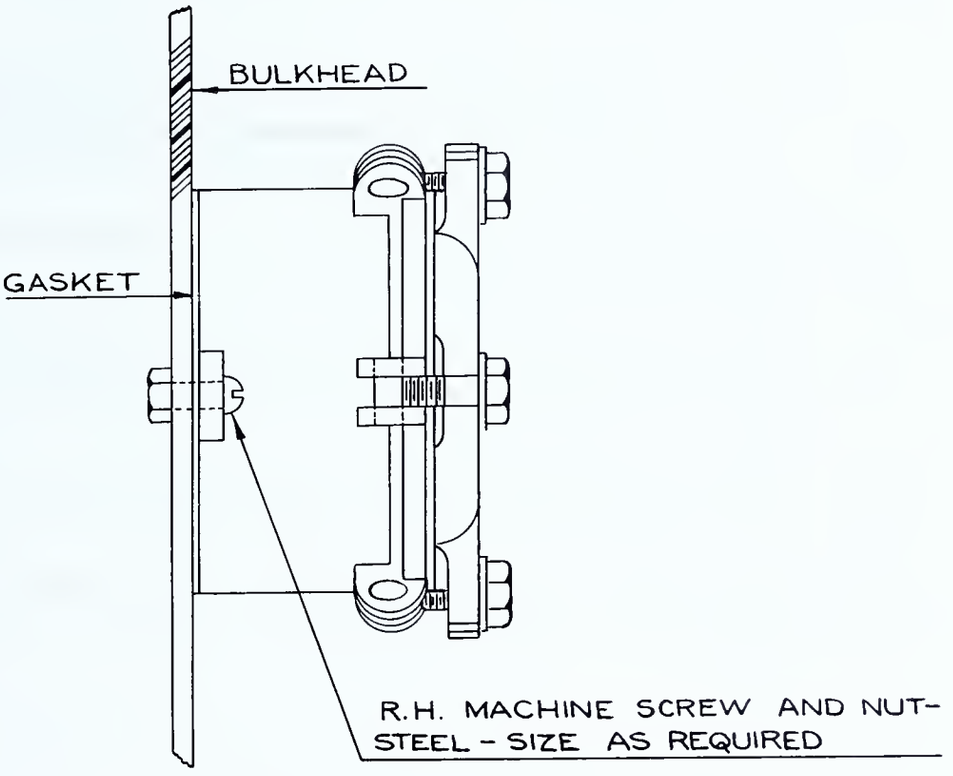


FIG-2

1. Template mounting holes from base of fixture or fitting to be mounted.

2. Spot and center punch centers of mounting holes in the desired location on the bulkhead, using the template.

3. Have holes drilled in bulkhead the same size as the mounting holes in the fixture or fitting.

4. Insert suitable round head machine screws through the mounting holes in the fixture or fitting and through the holes in the bulkhead and install hexagon nuts thereon.

5. Spot locations at which cables are to penetrate fixture or fitting and mark with chalk or crayon.

6. Remove the fixture or fitting from bulkhead and have holes drilled for terminal tubes or cable clamps, as outlined in Units 11 or 14 respectively.

7. Paint surface of bulkhead where fixture or fitting is to butt and bottom of fixture or fitting with one coat of zinc chromate primer.

8. Cut a canvas or canton flannel gasket, using the base of the fixture or fitting as a template.

9. Impregnate gasket with zinc chromate primer.

   Note: Where material is to be left bright, or where fixture or fitting is of the molded phenolic type, the gasket and the contact surfaces (Step 7) are painted with spar varnish of the phenolic type.

10. Insert gasket between fixture or fitting and bulkhead. See Fig. 2.

11. Insert round head machine screws through the mounting holes of the fixture or fitting, through the gasket and into the holes in the bulkhead.

12. Install shakeproof washers and hexagon nuts on machine screws. See Fig. 2.

13. Tighten nuts with an end wrench while holding machine screws with a screw driver.

METHOD LL

METHOD OF SECURING COMBINED WATERTIGHT FIXTURE AND APPLIANCE TO STEEL WATERTIGHT BULKHEAD

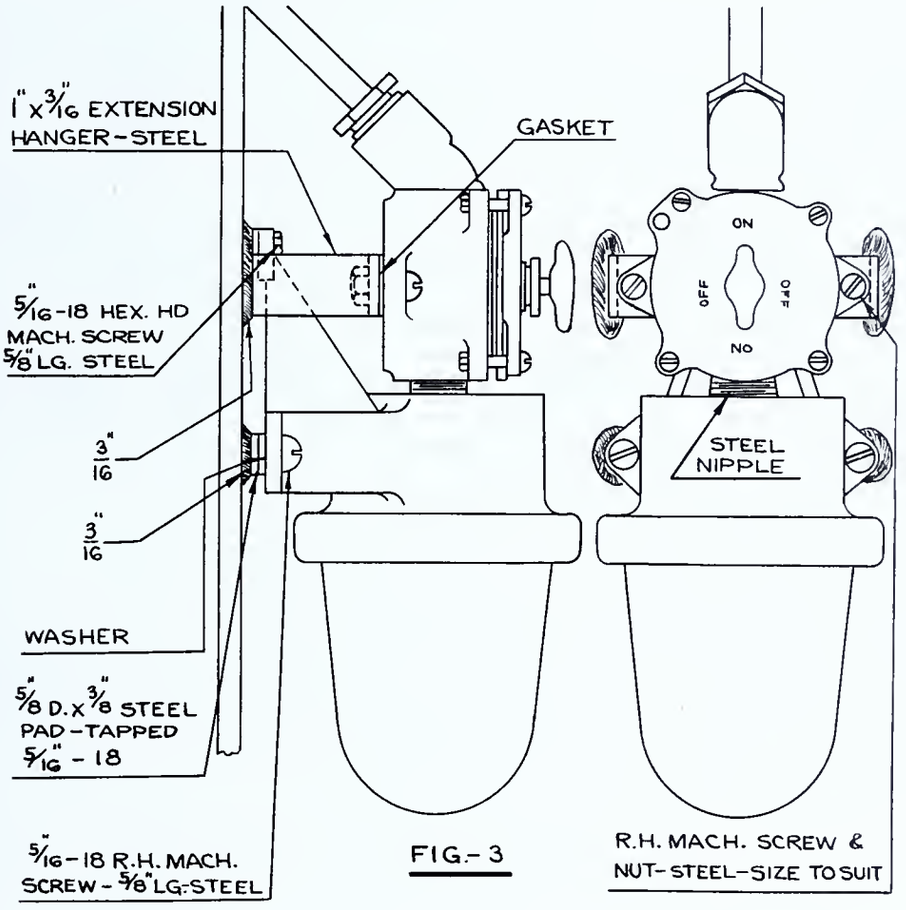

1" X 3/16 EXTENSION HANGER - STEEL
GASKET
5/16 - 18 HEX. HD MACH. SCREW 5/8" LG. STEEL
3/16"
3/16"
WASHER
5/8 D. X 3/8" STEEL PAD - TAPPED 5/16" - 18
5/16 - 18 R.H. MACH. SCREW - 5/8" LG. STEEL
ON
OFF
NO
STEEL NIPPLE
R.H. MACH. SCREW & NUT - STEEL - SIZE TO SUIT

FIG. - 3

1. Determine number of mounting holes in fixture to be mounted.

2. Draw from stock 5/8" D. x 3/8" steel pads with 5/16"-18 tapped holes. The number of pads required was determined in Step 1.

3. Install 5/16"-18 round head machine screws through the holes in the mounting feet of the fixture, and into the tapped hole of the pads.

4. Hold fixture in the desired location on the bulkhead and have welder tack-weld pads to the bulkhead. See Fig. 3.

5. Remove machine screws and fixture from pads and have welder fillet-weld pads all around as shown in Fig. 3.

6. Locate and center punch the center of the base of the fixture. See Fig. 3.

7. Drill and tap fixture at center punch for 3/4" I. P. S. thread.

8. Locate and center punch center of bosses on opposite sides of the appliance. See Fig. 3.

9. Drill and tap one side of appliance (at center punch) for 3/4" I. P. S. thread.

10. Drill and tap opposite side of appliance (at center punch) for terminal tube as outlined in Unit 11.

11. Obtain from stock one 3/4" I. P. S. close nipple (steel).

12. Apply red lead to threads of nipple and insert nipple into tapped hole in fixture and 3/4" I. P. S. tapped hole of appliance.

13. Tighten nipple by holding fixture and turning appliance; bring the appliance into the desired position with respect to the fixture. See Fig. 3.

14. Remount fixture on pads on bulkhead.

15. Measure distance from bulkhead to back of appliance.

16. Measure base of fitting (outside dimension over mounting feet).

17. Determine the length of the hanger material (twice the dimension obtained in Step 15 plus the dimension obtained in Step 16).

    Note: The above dimensions compensate for the clearance outside the nuts for the mounting screws of the appliance. See Fig. 3. Reason for this is that the distance usually subtracted from the dimension obtained in Step 15 (for thickness of hanger material and gasket) compensates for clearance outside the nut.

18. Determine bending points of hanger (dimensions obtained in Step 15 minus 1/4").

    Note: The 1/4" is the sum of the hanger material (3/16") and the gasket thickness (1/16").

19. Select a piece of 1" x 3/16" strap steel to suit the length determined in Step 17.

20. Scribe a line at right angles to the side of the hanger material, close to one end, using a square.

21. Mark off the dimension obtained in Step 17, starting at the line scribed in Step 20, and scribe a line perpendicular to the side, using a square.

22. Cut both ends along the scribed lines (Steps 20 and 21), using the bench shears.

23. Mark off the dimension obtained in Step 18 from each end of the material, and scribe lines perpendicular to the side.

24. Bend material at right angles (90°) along the lines scribed in Step 23 (both bends to be made in the same direction).

25. Template and drill mounting holes in hanger to suit appliance used.

26. Insert hanger between bulkhead and appliance, and insert suitable round head machine screws in the mounting holes of the fixture and the drilled holes in the hanger, and install hexagon nuts thereon. See Fig. 3.

27. Tighten nuts on machine screws.

28. Press against the appliance until the hanger rests against the bulkhead, then have welder tack-weld the sides of the hanger to the bulkhead.

29. Remove machine screws, hexagon nuts, fixtures and appliance from the hanger and pads, and instruct welder to fillet-weld hanger as shown in Fig. 3.

30. Paint surface of fixture, appliance, hanger and pads at the contact points, with one coat of zinc chromate primer.

31. Cut canvas or canton flannel washers, using the contact surfaces of the pads as templates.

32. Cut a canvas or canton flannel gasket, using the contact surface of the hanger as a template.

33. Impregnate gasket and washers with zinc chromate primer.

Note: Where material is to be left bright, the gasket, washers, and contact surfaces (Step 30) are painted with spar varnish of the phenolic type.

34. Install shakeproof washers on the round head machine screws.

35. Insert washers between fixture and pads, and insert round head machine screws through mounting holes of fixture, through washers and into the tapped holes of the pads. See Fig. 3.

36. Insert gasket between hanger and appliance (see Fig. 3) and install machine screws through mounting holes of appliance, gasket and the drilled holes in the hanger; then install shake-proof washers and hexagon nuts thereon.

37. Tighten supporting screws of fixture, using a screw driver.

38. Tighten supporting screws and nuts of appliance, using an end wrench and a screw driver.

METHOD LLL

METHOD OF SECURING COMBINED N.W.T. FIXTURE AND APPLIANCE TO W.T. OR N.W.T. STEEL OR ALUMINUM BULKHEADS

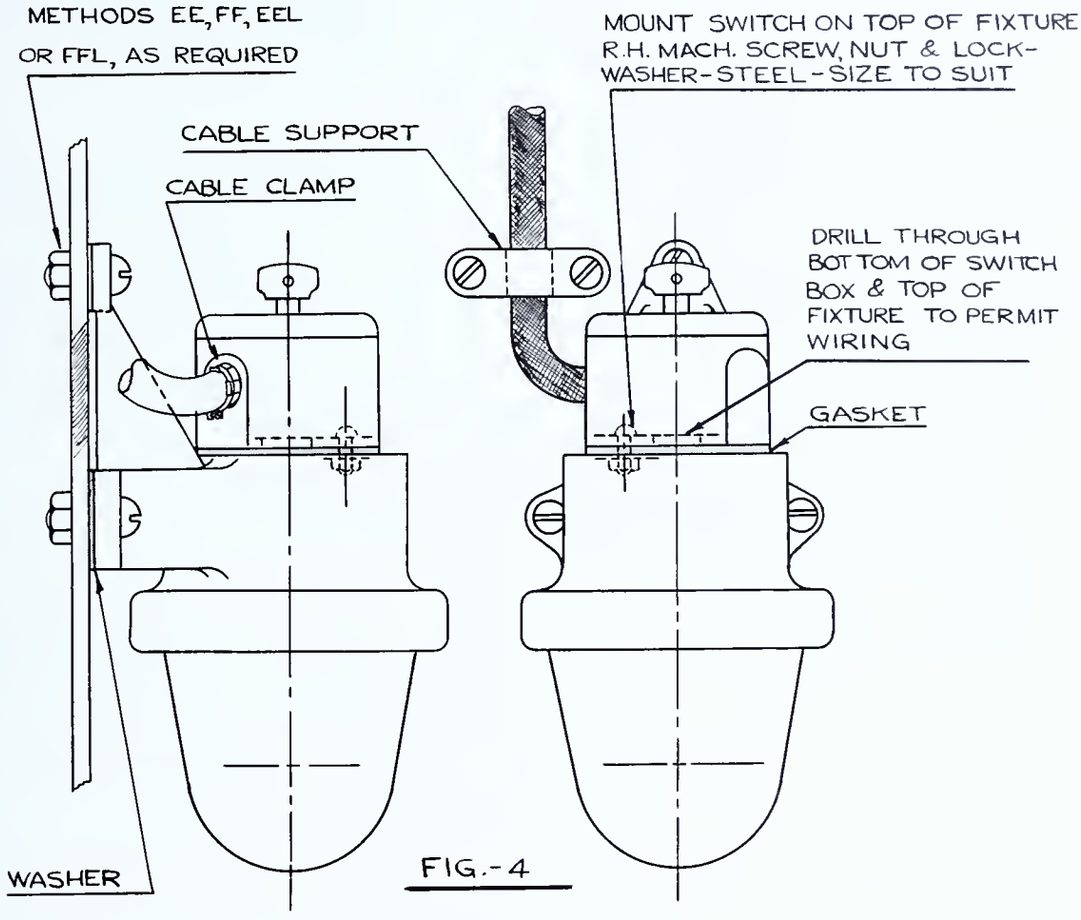

METHODS EE, FF, EEL OR FFL, AS REQUIRED
MOUNT SWITCH ON TOP OF FIXTURE R.H. MACH. SCREW, NUT & LOCK-WASHER-STEEL-SIZE TO SUIT
CABLE SUPPORT
CABLE CLAMP
DRILL THROUGH BOTTOM OF SWITCH BOX & TOP OF FIXTURE TO PERMIT WIRING
GASKET
WASHER

FIG.-4

1. Mount the fixture on the type bulkhead concerned as outlined for Methods EE, FF, EEL or FFL, omitting the washers.

2. Place appliance on top of the fixture and determine the position where the cable will enter the appliance. Mark this position with chalk or crayon at a corresponding point on the fixture.

3. Template the base of the appliance, being careful to mark location of "bosses" on the template.

4. Remove the fixture from the bulkhead.

5. Lay the template on the top of the fixture (aligning the center of the "boss" and the chalk mark for cable entrance). Mark, center punch and drill the mounting holes in the top of the fixture to suit the template.

6. Drill holes in the appliance for cable clamps as outlined in Unit 14.

7. Paint surfaces of fixture and appliance that are to butt with one coat of zinc chromate primer.

8. Cut a canvas or canton flannel gasket, using the contact surface of the appliance as a template.

9. Impregnate gasket with zinc chromate primer.

   Note: Where material is to be left bright, or where fixture or appliance is of the molded phenolic type, the gasket and the contact surface (Step 7) are painted with spar varnish of the phenolic type.

10. Insert gasket between fixture and appliance. See Fig. 4.

11. Insert suitable round head machine screws (steel) through the base of the appliance, the gasket and holes in the top of the fixture and install lock washers and hexagon nuts thereon. See Fig. 4.

12. Tighten hexagon nuts with an end wrench while holding the machine screws with a screw driver.

13. Cut washers and complete installation of fixture as outlined in Methods EE, FF, EEL or FFL.

METHOD DD

METHOD OF SECURING FIXTURE OR FITTING TO STEEL DECKS OR BULKHEADS HAVING INSULATION -- USING STOOLS

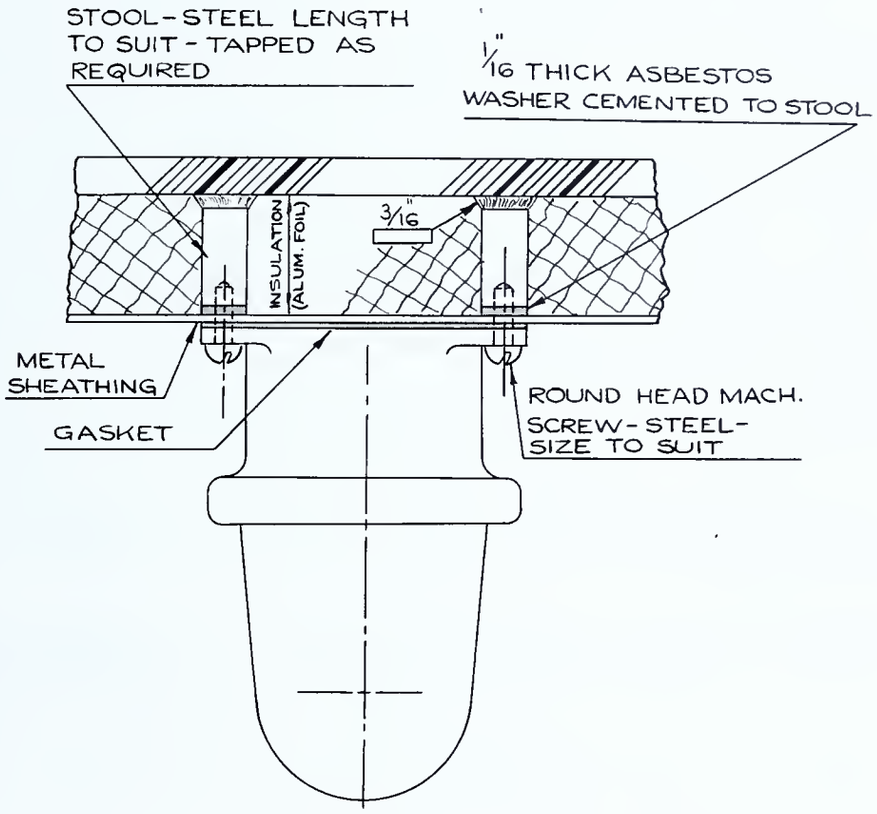

STOOL - STEEL LENGTH TO SUIT - TAPPED AS REQUIRED
1/16" THICK ASBESTOS WASHER CEMENTED TO STOOL
INSULATION (ALUM. FOIL)
3/16"
METAL SHEATHING
GASKET
ROUND HEAD MACH. SCREW - STEEL - SIZE TO SUIT

FIG - 5

1. Determine the number of mounting holes in the fixture or fitting to be mounted.

2. Determine thickness of insulation. See Fig. 5.

3. Determine length of stool required (thickness of insulation less 1/16").

   Note: The 1/16" is to permit the insertion of the washer. See Fig. 5.

4. Draw from stock stools of sufficient length to suit the dimension obtained in Step 3. The number of stools required was determined in Step 1.

   Note: The drilled and tapped hole in the stool must be suitable for machine screw intended to support the fixture. The size of the screw is determined by the drilled holes in the mounting feet or the base of the fixture or fitting.

5. Mark off the dimension obtained in Step 3 on each stool, starting from the tapped end of each stool.

6. If required, cut off excess ends of stools, using a hack saw and vise.

7. Install suitable round head machine screws through the mounting holes of the fixture or fitting and into tapped hole of stools.

8. Hold fixture or fitting in the desired location on the deck or bulkhead and have welder tack-weld the stools. See Fig. 5.

9. Remove machine screws and fixture or fitting from stools and have welder fillet-weld stools all around as shown in Fig. 5.

10. Remount the fixture or fitting on the stools, and spot locations at which cables are to penetrate fixture and mark with chalk or crayon.

11. Remove fixture or fitting from stools and have holes drilled for terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

12. Cut 1/16" thick asbestos washers, using stools as a template.

13. Cement a washer on each stool, using spar varnish or shellac. See Fig. 5.

14. After insulation and metal sheathing has been installed, have sheet metal worker template and drill holes in sheathing to permit installation of machine screws.

15. Paint surface of sheathing where fixture or fitting is to butt and bottom of fixture or fitting with one coat of zinc chromate primer.

16. Cut a canvas or canton flannel gasket, using the base of the fixture or fitting as a template.

17. Impregnate gasket with zinc chromate primer.

    Note: Where material is to be left bright, or where fixture or fitting is of the molded phenolic type, the gasket and the contact surface (Step 15) are painted with spar varnish of the phenolic type.

18. Insert gasket between fixture or fitting and sheathing. See Fig. 5.

19. Insert round head machine screws through the mounting holes of the fixture or fitting and into the tapped holes of the stools.

20. Tighten screws with a screw driver.

METHOD DDA

METHOD OF SECURING FIXTURE OR FITTING TO STEEL DECKS OR BULKHEADS HAVING INSULATION -- USING EXTENSION HANGERS

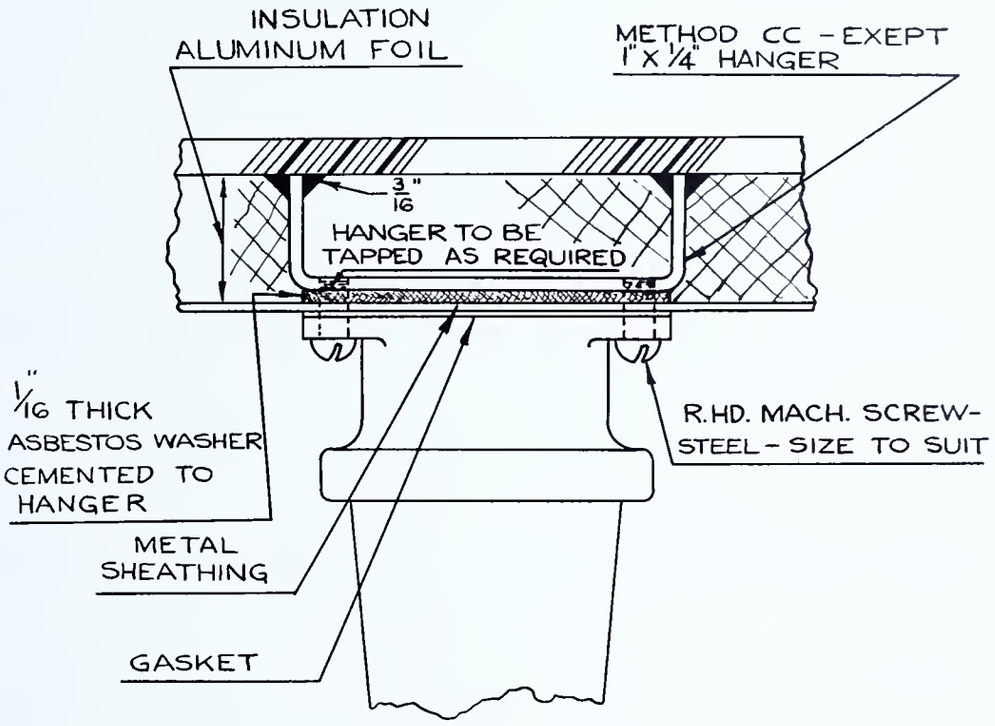


FIG.-6

1. Determine thickness of insulation. See Fig. 6.

2. Determine the length of the side of the hanger (thickness of insulation, Step 1, less 1/16" for asbestos washer less 1/4" for thickness of the hanger material). See Fig. 6.

3. Measure base of fixture or fitting to be mounted (outside dimension).

4. Determine length of hanger material (twice the dimension obtained in Step 2 plus dimension obtained in Step 3).

5. Determine number of mounting holes in the fixture or fitting.

6. Select a piece of 1" x 1/4" strap steel to suit the length determined in Step 4.

Notes: (a) Fixtures or fittings having two mounting holes require only one hanger.

(b) Fixtures or fittings having more than two mounting holes require a hanger at each set of holes.

7. Scribe a line at right angles to the side of the hanger material, close to one end, using a square.

8. Mark off dimension obtained in Step 4, starting at the line scribed in Step 7, and scribe a line perpendicular to the side, using a square.

9. Cut both ends along the scribed lines (Steps 7 and 8), using a hack saw.

10. Mark off the dimension obtained in Step 2 from each end of the material and scribe lines perpendicular to the side.

11. Bend material at right angles (90°) along the lines scribed in Step 10 (both bends to be made in the same direction).

12. Template, drill and tap mounting holes in hanger to suit fixture or fitting used.

13. Hold hanger in a level position against the deck or bulkhead in the desired location and have welder tack-weld the sides.

14. Instruct welder to fillet-weld hanger to deck or bulkhead as shown in Fig. 6.

15. Install suitable round head machine screws through the mounting holes of the fixture or fitting and into the tapped holes in the hanger.

16. Spot locations at which cables are to penetrate the fixture or fitting and mark with chalk or crayon.

17. Remove the fixture or fitting from the hanger and have holes drilled for terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

18. Cut 1/16" thick asbestos washer, using hangers as templates.

19. Cement a washer to each hanger, using spar varnish or shellac. See Fig. 6.

20. After insulation has been installed, have sheet metal worker template and drill holes in sheathing to permit installation of machine screws.

21. Paint surface of sheathing where fixture or fitting is to butt and bottom of fixture with one coat of zinc chromate primer.

22. Cut a canvas or canton flannel gasket, using the base of the fixture as a template.

23. Impregnate gasket with zinc chromate primer.

    Note: Where material is to be left bright, or where fixture or fitting is of the molded phenolic type, the gasket and the contact surfaces (Step 21) are painted with spar varnish of the phenolic type.

24. Insert gasket between fixture or fitting and sheathing. See Fig. 6.

25. Insert round head machine screws through the mounting holes of the fixture or fitting and into the tapped holes of the hanger.

26. Tighten screws with a screw driver.

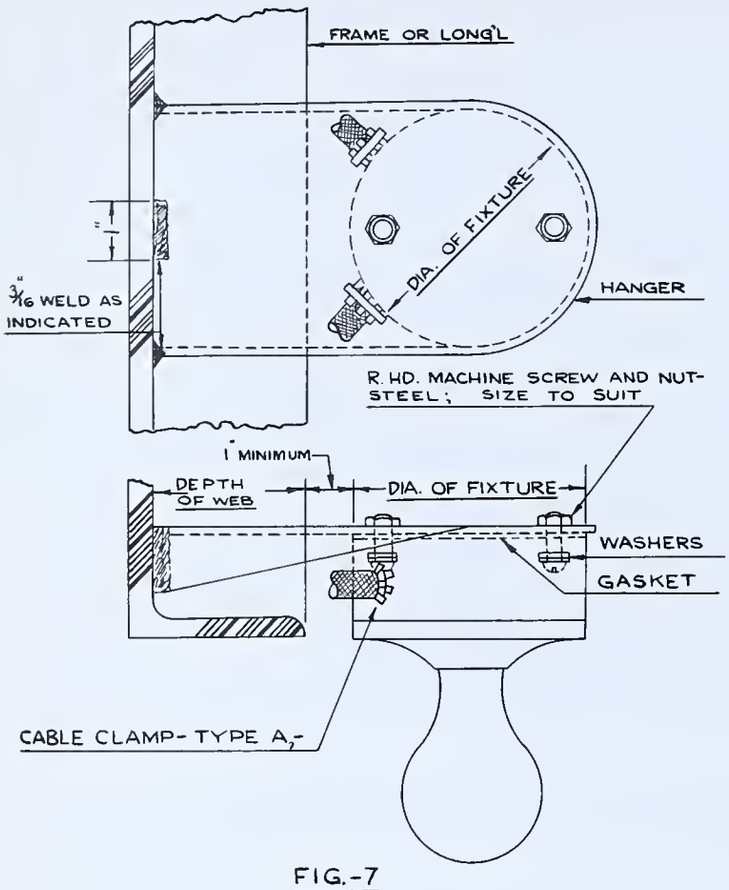


FIG.-7

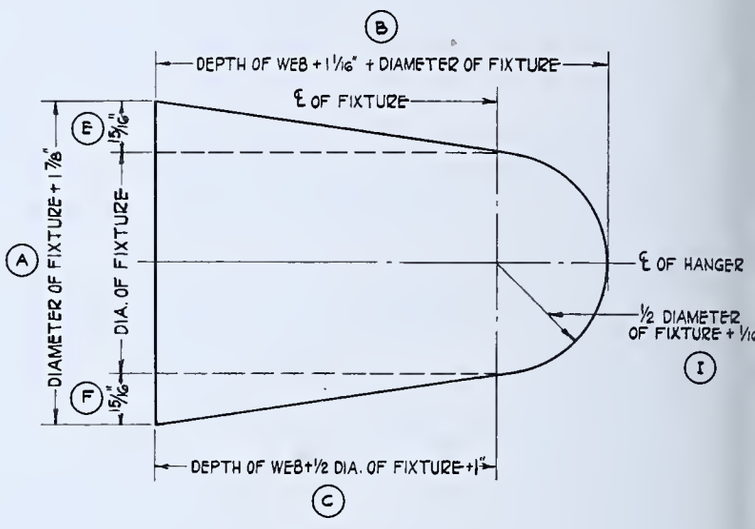
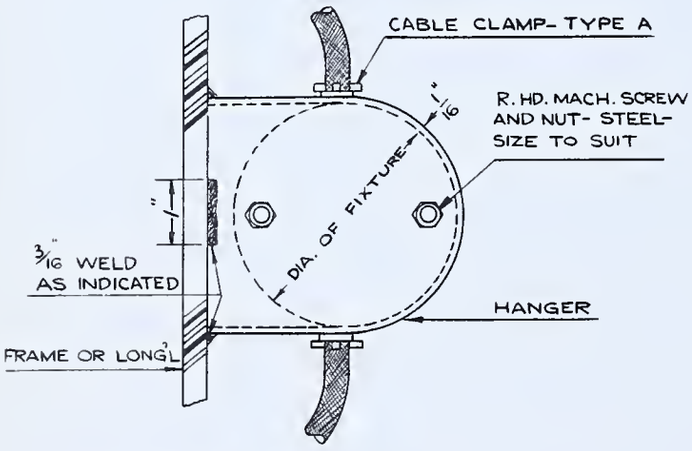


FIG.-8



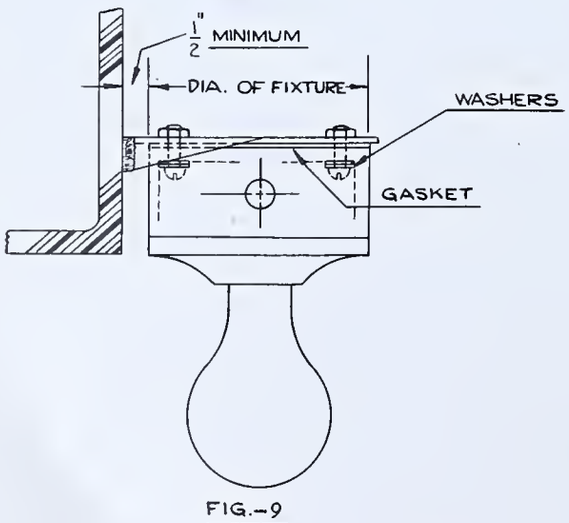


FIG.-9

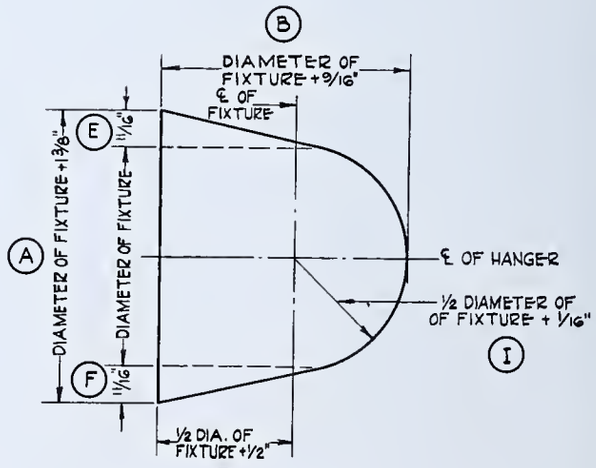


FIG.-10

METHODS OF SECURING FIXTURES TO STEEL FRAME OR LONGITUDINAL

AA - INSIDE A WEB

BB - TO FACE OF FRAME

The method of securing fixtures to the inside of the web, or to the face of a steel frame, will vary only in the length of the fixture support. The clearance for the web type is 1" from the edge of the flange; for the face type the clearance is only $\frac{1}{2}$" from the face. See Figs. 7 and 10.

In following these procedures careful attention should be paid to the sketches accompanying this unit.

Procedure:

1. Measure diameter of base of fixture.

2. Determine the length of hanger.

   Type AA
   Depth of web - minimum clearance - diameter of fixture - 1/16" outside of fixture clearance.

   Type BB
   Minimum clearance - diameter of fixture - 1/16" outside of fixture clearance.

3. Determine width of hanger material.
   Diameter of fixture - 1/8" fixture clearance - depth of both sides. See Figs. 8 and 10.

4. Select piece of 1/16" sheet metal to suit dimensions obtained in Steps 2 and 3.

5. Shear end of metal. This straight end will butt against the structure.

6. Locate center of this straight end.

7. Scribe line at right angles to end using a square. This line is the center line of hanger. See Figs. 8 and 10.

8. Obtain center line of fixture by measuring from end.
   (Web clearance - minimum clearance - radius of fixture).
   See Figs. 8 and 10.

9. Scribe line perpendicular to the center line of the hanger.

10. Set dividers the radius of the fixture plus 1/16" clearance, and scribe a semi-circle using point of intersection of center lines as center. See Figs. 8 and 10.

11. Mark off on the straight end of this same distance each side of center line of hanger.

12. Scribe lines from these marks parallel to the center line of hanger. (These will be the bend lines for the sides of bracket.)

13. Measure beyond these points on the straight end the depth of each side.

14. Scribe a line from these points tangent to the semi-circle.

15. Cut around the outer lines, using bench shears.

16. Grind edges smooth on emery wheel.

17. Bend sides at right angles (90°) to the base, along the lines determined in Step 12, using the bending machine. (Bend in same direction.)

18. Template and drill mounting holes in hanger to suit fixture.

19. Hold hanger in a level position against the outside of the structural member.

20. Have hanger tack-welded in position and then fillet welded.

21. Insert proper round head screws through base of fixture and through holes of hanger and place nuts thereon.

22. Tighten nuts hand-tight.

23. Spot location at which cables are to enter fixture and mark with chalk or crayon.

24. Remove fixture from hanger and have holes drilled for terminal tubes or cable clamps as outlined in Units 11 and 14, respectively.

25. Paint surface of hanger where fixture is to butt with one coat of zinc chromate primer.

26. Cut a canvas or canton flannel gasket, using the base of the fixture as a template.

27. Impregnate gasket with zinc chromate primer.

    Note: Where material is to be left bright, or where fixture is of the molded phenolic type, the gasket and the contacting surface (Step 25) are painted with spar varnish of the phenolic type.

28. Insert gasket between fixture and hanger. See Fig. 9.

29. Install metal washer on round head machine screws and insert screw through fixture and hanger. See Fig. 9.

30. Install shakeproof washers and hexagon nuts on machine screws.

31. Tighten the hexagon nuts with an end wrench, holding the machine screws with a screw driver.

METHOD CC

METHOD OF SECURING FIXTURE OR FITTING TO STEEL

DECK OR BULKHEAD - WITHOUT INSULATION - EXTENSION IN WAY OF WIRING

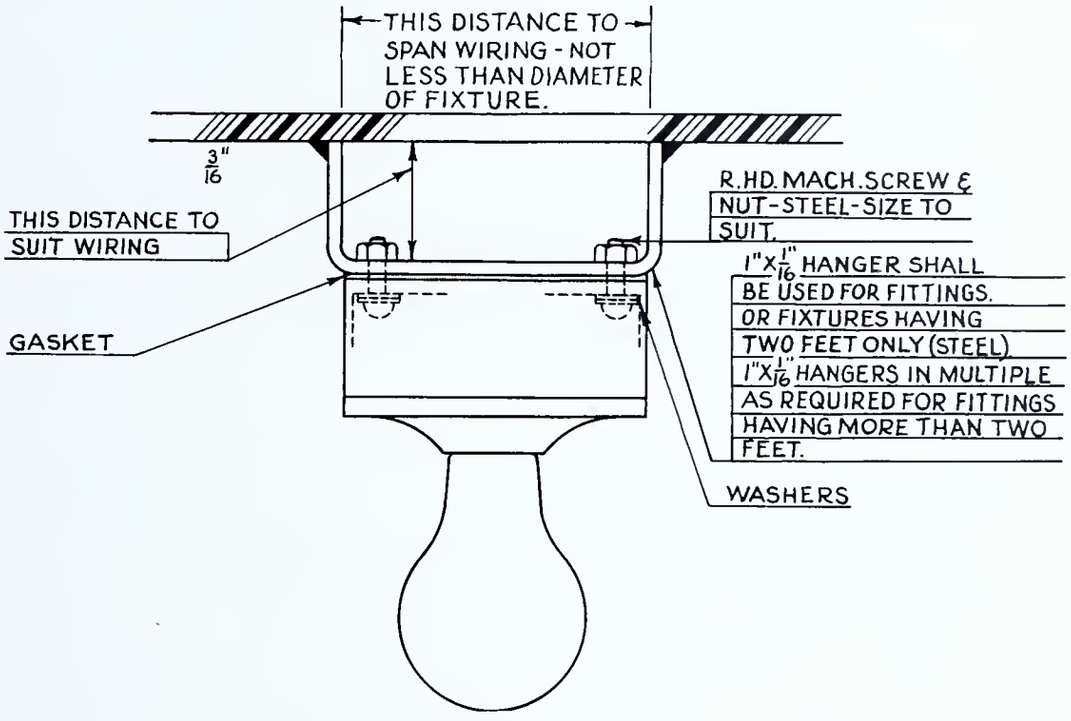

THIS DISTANCE TO SPAN WIRING - NOT LESS THAN DIAMETER OF FIXTURE.
3/16"
THIS DISTANCE TO SUIT WIRING
GASKET
R.HD.MACH.SCREW & NUT-STEEL-SIZE TO SUIT.
1"X1/16" HANGER SHALL BE USED FOR FITTINGS OR FIXTURES HAVING TWO FEET ONLY (STEEL)
1"X1/16" HANGERS IN MULTIPLE AS REQUIRED FOR FITTINGS HAVING MORE THAN TWO FEET.
WASHERS

FIG.11

1. Measure distance from deck or bulkhead required to clear wiring. See Fig. 11.

2. Measure distance required to span wiring (dimension not to be less than diameter of fixture plus 1/2").

   Note: The 1/2" is to permit 1/4" on each side for clearance.

3. Determine length of hanger material (twice the dimension obtained in Step 1 plus dimension obtained in Step 2).

4. Measure base of fixture to be mounted.

5. Determine number of mounting holes or mounting feet on the fixture.

6. Select a piece of 1" x 1/16" strap steel to suit the length determined in Step 3.

   Notes: (a) Fixtures or fittings having two mounting holes or mounting feet require only one hanger.

   (b) Fixtures or fittings having more than two mounting holes or mounting feet require a hanger at each set of holes.

7. Scribe a line at right angles to the side of the hanger material, close to one end, using a square.

8. Mark off dimension obtained in Step 3, starting at the line scribed in Step 7 and scribe a line perpendicular to the side, using a square.

9. Cut both ends along the scribed lines (Steps 7 and 8), using the bench shears.

10. Mark off the dimension obtained in Step 1, from each end of the material, and scribe lines perpendicular to the side.

11. Bend material at right angles (90°) along the lines scribed in Step 10 (both bends to be made in the same direction).

12. Template the drill mounting holes in hanger to suit fixture used.

13. Hold hanger in a level position against the deck or bulkhead in the desired location and have welder tack-weld the sides of the hanger to the deck or bulkhead.

14. Instruct welder to fillet-weld hanger to deck or bulkhead as shown in Fig. 11.

15. Insert suitable round head machine screws through the mounting holes of the fixture and through the holes in the hanger, and install hexagon nuts thereon.

16. Tighten nuts hand-tight.

17. Spot locations at which cables are to penetrate fixture and mark with chalk or crayon.

18. Remove fixture from hanger and have holes drilled for terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

19. Paint surface of hanger and fixture (where they are to butt) with one coat of zinc chromate primer.

20. Cut a canvas or canton flannel gasket, using the contact surface of the hanger as a template.

21. Impregnate gasket with zinc chromate primer.

    Note: Where material is to be left bright, or where fixture or fitting is of the molded phenolic type, the gasket and the contact surface (Step 19) are painted with spar varnish of the phenolic type.

22. Insert gasket between fixture or fitting and hanger. See Fig. 11.

23. Install metal washer on round head machine screws and insert screw through fixture or fitting and hanger. See Fig. 11.

24. Install shakeproof washers and hexagon nuts on the machine screws.

25. Tighten the nuts with an end wrench, while holding the screws with a screw driver.

METHOD QQQ

METHOD OF MOUNTING FIXTURES ON A DECK (OF SURFACE VESSELS) WHERE NECESSARY TO AVOID OBSTRUCTIONS

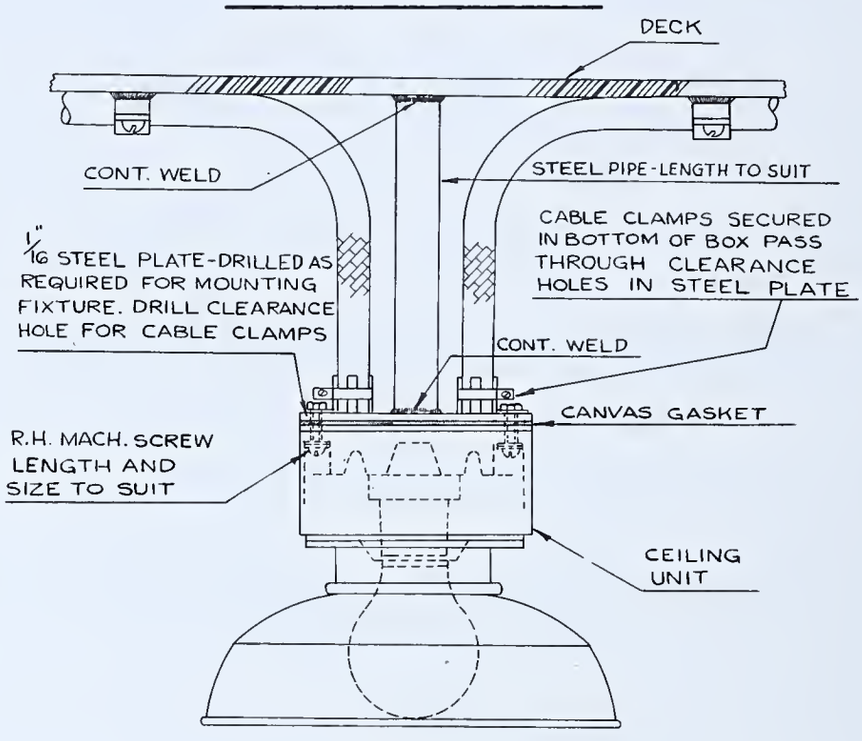

DECK
CONT. WELD
STEEL PIPE-LENGTH TO SUIT
CABLE CLAMPS SECURED IN BOTTOM OF BOX PASS THROUGH CLEARANCE HOLES IN STEEL PLATE
1/16" STEEL PLATE-DRILLED AS REQUIRED FOR MOUNTING FIXTURE. DRILL CLEARANCE HOLE FOR CABLE CLAMPS
CONT. WELD
CANVAS GASKET
R.H. MACH. SCREW LENGTH AND SIZE TO SUIT
CEILING UNIT

FIG.-12

1. Determine distance required to clear obstruction.

2. Determine the size of the galvanized steel pipe required to support the fixture.

   Note: Pipe sizes are determined as follows:

   (a) Small Phenolic Fixtures:
   3/4" pipe if mounted less than 15" from the deck.
   1" pipe if mounted over 15" from the deck.

   (b) Metallic and Large Phenolic Fixtures:
   1½" pipe if mounted less than 15" from the deck.
   2" pipe if mounted over 15" from the deck.

3. Template base of fixture to be mounted.

4. Select a piece of 1/16" steel plate to suit the template (Step 3), and a length of pipe to satisfy dimensions obtained in Steps 1 and 2.

5. Cut the steel plate to suit the template, using the bench shears.

6. Grind edges of steel plate smooth using the emery wheel.

7. Locate and center punch the center of the steel plate.

8. Drill mounting holes in the steel plate to suit mounting holes of the fixture.

9. Scribe a circle whose diameter is equal to the outside diameter of the pipe, using the center of the plate (Step 7) as the center of the circle.

10. Insert suitable round head machine screws through the mounting holes of the fixture and the mounting holes of the steel plate, and install hexagon nuts thereon.

11. Tighten nuts with an end wrench while holding the machine screws with a screw driver.

12. Determine the number, size and type of cables that are to penetrate the fixture.

13. Spot and center punch the locations that cables will penetrate, on the steel plate.

    Note: The electrician should be careful to note that there will be sufficient clearance outside the circle scribed in Step 9 to permit drilling for cable clamps or terminal tubes.

14. Drill, or drill and tap, holes in the plate and fixture at locations marked in Step 11, for terminal tubes or cable clamps, as outlined in Units 11 or 14, respectively.

15. Cut the galvanized pipe to the length determined in Step 1, using the power hack saw.

    Note: The power hack saw is specified to assure the cutting of the end of the pipe at right angles to its length.

16. Remove round head machine screws and hexagon nuts holding the fixture and steel plate together.

17. Lay plate flat on the deck, place one end of the pipe on the plate (inside the circle, Step 9), and instruct welder to fillet-weld (all around) the pipe to the plate. See Fig. 12.

18. Paint the bottom of the steel plate and the bottom of the fixture with one coat of zinc chromate primer.

    Note: Where material is to be left bright, the contact surfaces are painted with spar varnish of the phenolic type instead of the zinc chromate primer.

19. Cut a canvas gasket, using the base of the fixture as a template.

20. Impregnate gasket with zinc chromate primer.

    Note: Where molded phenolic fixture is used, the gasket is painted with spar varnish of the phenolic type instead of zinc chromate primer.

21. Insert round head machine screws through the mounting holes in the fixture, the gasket and the mounting holes in the steel plate.

22. Install shakeproof washers and hexagon nuts on the machine screws. See Fig. 12.

23. Tighten the hexagon nuts with a wrench while holding the machine screws with a screw driver.

24. Insert terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

25. Place the open end of the pipe against the deck in the desired location, and instruct welder to tack-weld the pipe to the deck.

26. Have welder fillet-weld pipe all around. See Fig. 12.

METHOD GG

METHOD OF SECURING FIXTURE OR FITTING TO STANCHION

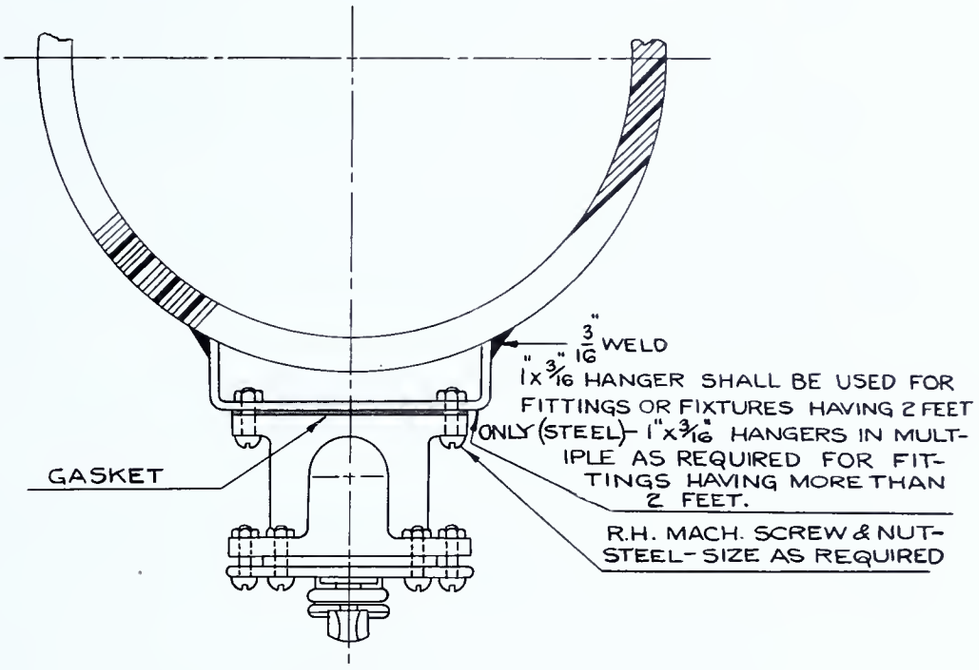

3/16" WELD
1"x3/16" HANGER SHALL BE USED FOR FITTINGS OR FIXTURES HAVING 2 FEET ONLY (STEEL)- 1"x3/16" HANGERS IN MULTIPLE AS REQUIRED FOR FITTINGS HAVING MORE THAN 2 FEET.
GASKET
R.H. MACH. SCREW & NUT-STEEL- SIZE AS REQUIRED

FIG.-13

1. Measure base of fixture or fitting to be mounted. (Outside dimension over mounting feet.)

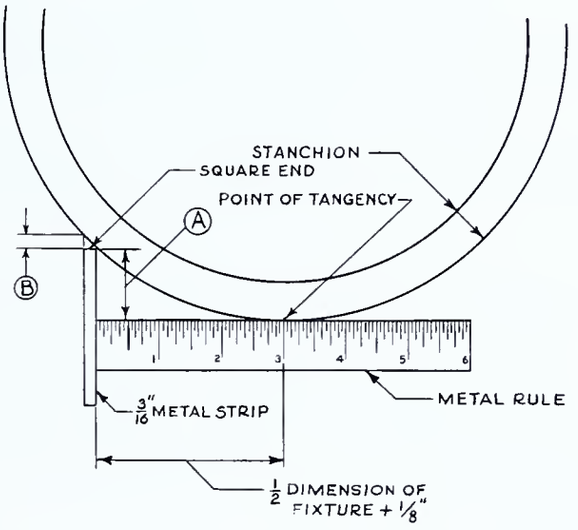


FIG. 14

2. Determine dimensions A and B of Fig. 14.

This is accomplished by placing a steel rule tangent to the stanchion and parallel to the deck. Slide the rule across the stanchion until the distance between the end of the rule and the point of tangency is equal to 1/2 the dimension obtained in Step 1 plus 1/8". See Fig. 14. Place a piece of 3/16" metal along the edge of the rule until it butts the stanchion. See Fig. 14. Dimensions A and B may then be measured.

3. Dimension the length of the side of the hanger (A plus B of Fig. 14 plus 1/2").

   Note: The 1/2" is the clearance between the stanchion and the center of the hanger.

4. Determine the length of the hanger material (twice the dimension obtained in Step 3 plus the dimension obtained in Step 1 plus 1/4").

   Note: The 1/4" is allowed for clearance outside of fixture. See Fig. 13.

5. Determine the number of mounting holes or mounting feet on the fixture or fitting.

6. Select a piece of 1" x 3/16" strap steel to suit the length determined in Step 4.

   Notes: (a) Fixtures or fittings having two mounting holes or mounting feet require only one hanger.

   (b) Fixtures or fittings having more than two mounting holes or mounting feet require a hanger at each set of holes.

7. Scribe a line at right angles to the side of the hanger material, close to one end, using a square.

8. Mark off dimension obtained in Step 4, starting at the line scribed in Step 7, and scribe a line perpendicular to the side, using a square.

9. Cut both ends along the scribed lines (Steps 7 and 8), using the bench shears.

10. Mark off dimension obtained in Step 3 from each end of the material and scribe lines perpendicular to the side.

11. Bend material at right angles (90°) along the lines scribed in Step 10 (both bends to be made in the same direction).

12. Template and drill mounting holes in hanger to suit fixture or fitting used.

13. Mark off dimension B (Step 2) from each end of the material (on the inside of the hanger) and scribe lines perpendicular to the side.

14. File ends of hanger between lines scribed in Step 13 and outside corners of hanger.

15. Hold hanger in a level position against the stanchion in the desired location and have welder tack-weld the sides.

16. Instruct welder to fillet-weld hanger to deck or bulkhead as shown in Fig. 13.

17. Insert suitable round head machine screws through the base of the fixture and through the holes on the hanger, and install hexagon nuts thereon.

18. Tighten nuts hand-tight.

19. Spot locations at which cables are to penetrate the fixture or fitting and mark with chalk or crayon.

20. Remove fixture from stools and have holes drilled for terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

21. Paint surface of hanger where fixture is to butt with one coat of zinc chromate primer.

22. Cut a canvas or canton flannel gasket, using the contact surface of the hanger as a template.

23. Impregnate gasket with zinc chromate primer.

    Note: Where material is to be left bright, or where fixture or fitting is of the molded phenolic type, the gasket and the contact surface (Step 21) are painted with spar varnish of the phenolic type.

24. Insert gasket between appliance and hanger. See Fig. 13.

25. Insert round head machine screws through the mounting holes of the fixture or fitting, throught the gasket and the drilled holes in the hanger.

26. Install shakeproof washers and hexagon nuts on machine screws. See Fig. 13.

27. Tighten nuts with an end wrench, holding the machine screws with a screw driver.

METHOD NNN

METHOD OF SECURING FIXTURE OR FITTING

TO EXPANDED METAL OR WIRE MESH BULKHEADS

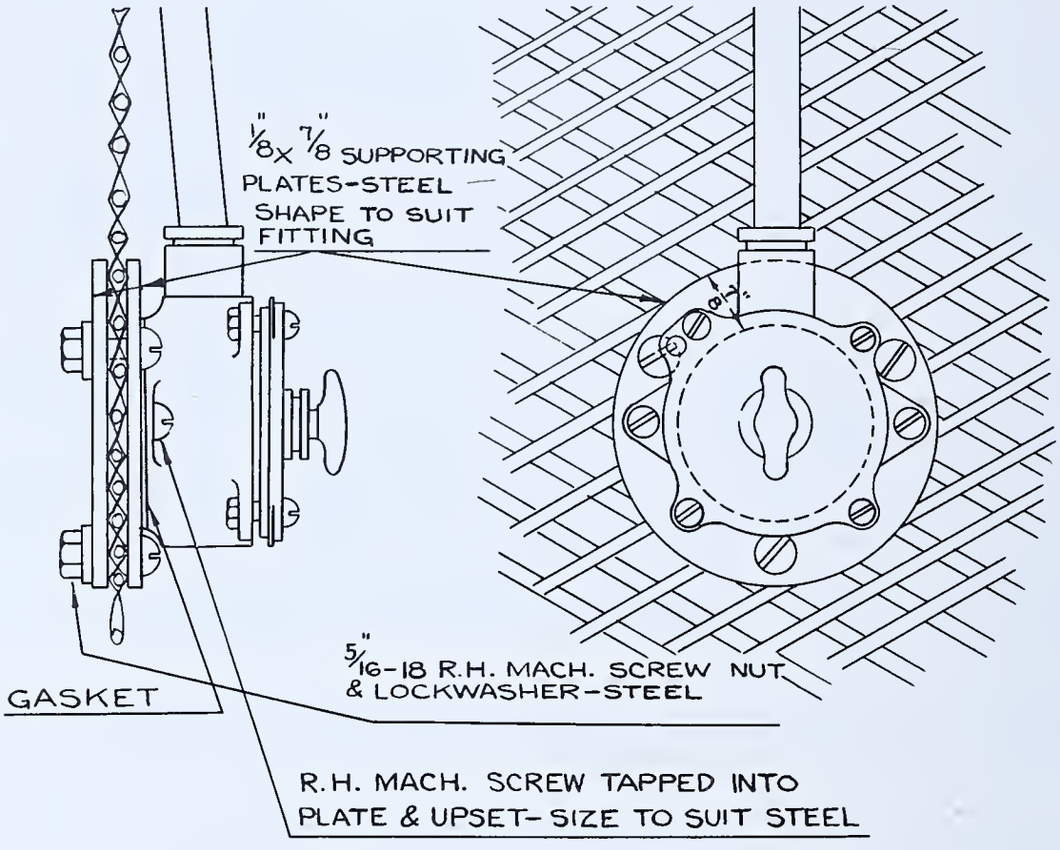

1/8" X 7/8" SUPPORTING PLATES-STEEL — SHAPE TO SUIT FITTING
5/16-18 R.H. MACH. SCREW NUT & LOCKWASHER-STEEL
GASKET
R.H. MACH. SCREW TAPPED INTO PLATE & UPSET- SIZE TO SUIT STEEL

FIG.-15

1. Template base of fixture or fitting to be mounted.

2. Select two pieces of 1/8" steel plate that will be 7/8" larger (all around) than the template (Step 1) (exclusive of mounting feet).

3. Trim the plates to a dimension 7/8" larger (all around) than the template (exclusive of mounting feet), using the bench shears.

4. Grind edges of plates smooth on the grinding wheel.

5. Locate and center punch the center of both plates.

6. Center punch, drill and tap the plate to suit the mounting holes of the fixture or fitting to be used, using the template.

7. Mark and scribe lines 1/4" from the inner side of the tapped holes (Step 6) toward the center of the plate.

   Note: If the plate is round, the line should be scribed with a compass.

8. Cut out the metal inside the lines scribed in Step 7. This is accomplished by drilling sufficient holes adjacent to each other to permit insertion of a hacksaw blade. With the insertion of the hacksaw blade the center of the plate can be cut out.

9. File the inner edges of the plate smooth, using a file.

10. Remove the center portion of the second plate as outlined in Steps 8 and 9, using the first plate as a template.

11. Insert suitable round head machine screws through the mounting holes of the fixture or fitting and into the tapped holes in the plate.

12. Hold fixture or fitting and plate against the bulkhead in the desired position. Spot, mark and center punch positions on the plate for bolts to pass through the openings on the wire mesh.

13. Remove fixture or fitting from the plate.

14. Clamp both plates together.

15. Drill 3/8" holes through both plates in the locations determined in Step 12.

16. Install plates on the bulkhead as shown in Fig. 15.

17. Mount fixture or fitting on the plate with the tapped holes.

18. Spot locations at which cables are to penetrate fixture or fitting and mark with chalk or crayon.

19. Remove the fixture or fitting from the plate and have holes drilled for terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

20. Paint surface of the plate and the bottom of the fixture or fitting with one coat of zinc chromate primer.

21. Cut a canvas or canton flannel gasket, using the base of the fixture or fitting as a template.

22. Impregnate gasket with zinc chromate primer.

    Note: Where material is to be left bright, or where fixture is of the molded phenolic type, the gasket and the contact surfaces (Step 20) are painted with spar varnish of the phenolic type.

23. Insert gasket between fixture or fitting and the plate. See Fig. 15.

24. Install a shakeproof washer on each round head machine screw.

25. Insert machine screws through the mounting holes of fixture or fitting, and into the tapped holes in the plate.

26. Tighten screws with a screw driver.

METHOD MMM

METHOD OF SUPPORTING FIXTURE OR FITTING ON CABLE RACKS

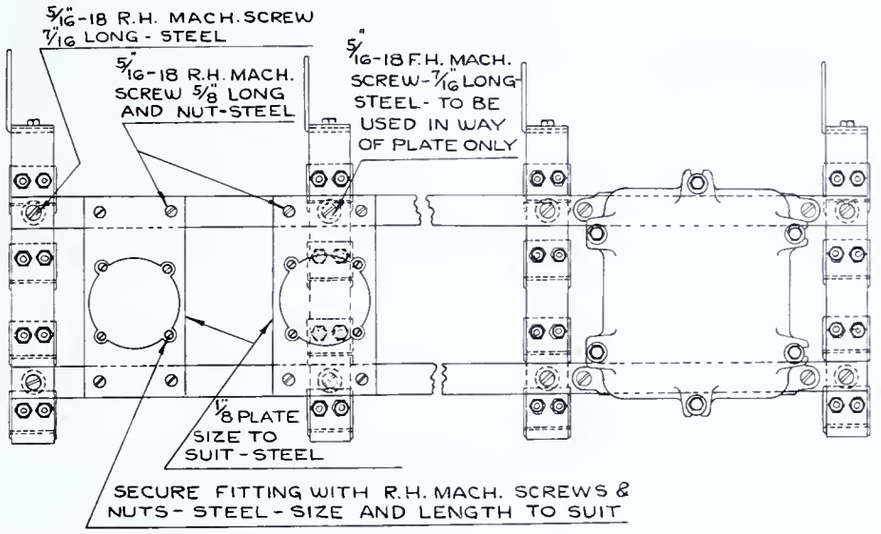

5/16"-18 R.H. MACH. SCREW 7/16 LONG - STEEL
5/16"-18 R.H. MACH. SCREW 5/8" LONG AND NUT-STEEL
5/16"-18 F.H. MACH. SCREW-7/16" LONG STEEL- TO BE USED IN WAY OF PLATE ONLY
1/8 PLATE SIZE TO SUIT - STEEL
SECURE FITTING WITH R.H. MACH. SCREWS & NUTS - STEEL - SIZE AND LENGTH TO SUIT

FIG.- 16

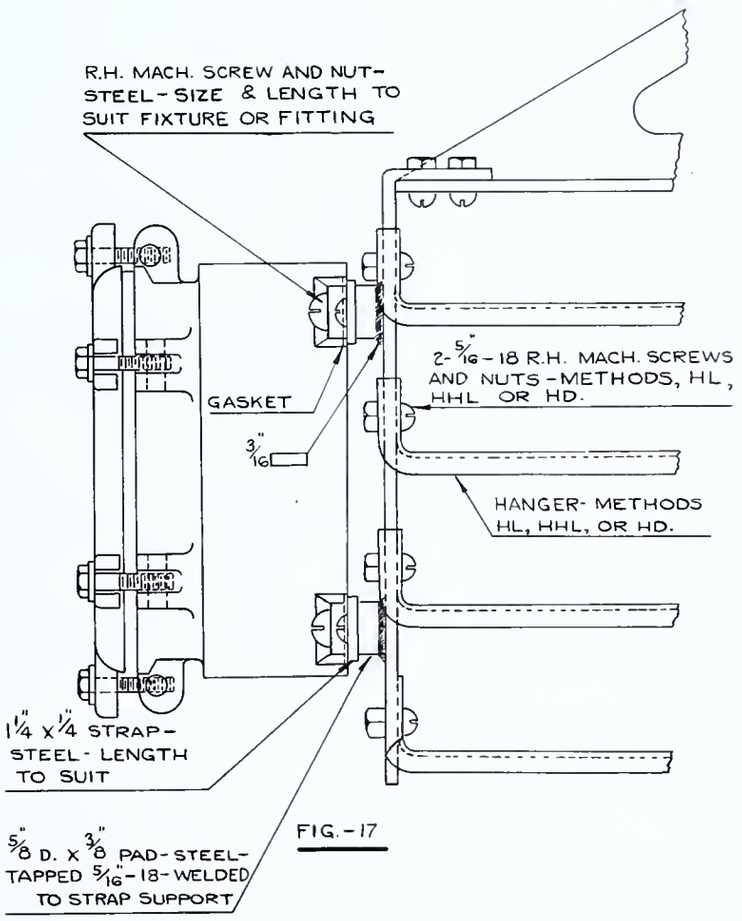

R.H. MACH. SCREW AND NUT- STEEL - SIZE & LENGTH TO SUIT FIXTURE OR FITTING
2-5/16"-18 R.H. MACH. SCREWS AND NUTS - METHODS, HL, HHL OR HD.
GASKET
3/16"
HANGER- METHODS HL, HHL, OR HD.
1 1/4" x 1/4" STRAP- STEEL - LENGTH TO SUIT
5/8" D. x 3/8" PAD- STEEL- TAPPED 5/16"-18- WELDED TO STRAP SUPPORT

FIG.- 17

1. Determine the distance between sets of mounting holes of the largest fixture or fitting to be mounted. See Fig. 16.

2. Determine the distance along the cable rack required for mounting fixtures or fittings.

   Note: Where a group of fixtures are to be mounted in one area on the rack, the distance required is measured between wireway supports that will satisfy the space required.

3. Measure distances between centers of all rack supports between the limits determined in Step 2.

4. Select two pieces of $1\frac{1}{4}$" x 1/4" strap steel to suit the length determined in Step 2.

5. Scribe a line at right angles to the side of the strap steel, close to one end, using a square.

6. Mark off the dimension obtained in Step 2, starting at the line scribed in Step 7, and scribe a line perpendicular to the side, using a square.

7. Cut both ends of each piece of strap steel along the scribed lines (Steps 5 and 6) using a hack saw.

8. Mark off the dimensions obtained in Step 3 from the end of the straps and scribe lines perpendicular to the sides.

9. Measure 5/8" from the side of the straps and scribe a line parallel to the sides for the full length of the strap.

10. Center punch and drill 3/8" holes in the straps at the intersections of the lines scribed in Steps 8 and 9.

    Note: If strap mounting screws are in the way of mounting plates, the holes should be countersunk for 5/16"-18 flat head machine screws. See Fig. 16.

11. Draw from stores sufficient 5/8" diameter x 3/8" steel pads tapped for 5/16"-18 machine screws, to suit the number of holes drilled in the straps.

12. Insert suitable 5/16"-18 machine screws through the holes in the straps and into the tapped holes of the pads and tighten with a screw driver.

13. Hold straps so that the pads are against the rack supports in the desired location and have welder tack-weld pads to the rack supports.

14. Remove machine screws and straps from the pads and have the welder fillet-weld the pads all around. See Fig. 17.

15. Remount the straps on the pads.

A. For The Larger Fixture or Fitting

16. Spot and center punch locations of mounting holes on the strap supports.

17. Drill holes the size of the mounting holes in the fixture or fitting through the strap supports at the locations determined in Step 16.

18. Insert suitable round head machine screws through the mounting holes of the fixture or fitting and through the holes in the strap supports and install hexagon nuts thereon.

19. Tighten nuts hand-tight.

20. Spot locations at which cables are to penetrate the fixture or fitting and mark with chalk or crayon.

21. Remove fixture or fitting from the strap supports and drill and tap for terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

22. Paint surfaces of strap supports and bottom of fixture or fitting that are to butt with one coat of zinc chromate primer.

23. Cut a canvas or canton flannel gasket, using the contact surface of the hanger as a template.

24. Impregnate gasket with zinc chromate primer.

Note: Where material is to be left bright, or where fixture or fitting is of the molded phenolic type, the gasket and the contact surfaces (Step 22) are painted with a spar varnish of the phenolic type.

25. Insert gasket between fixture or fitting and hanger. See Fig. 17.

26. Insert suitable round head machine screws through the mounting holes of the fixture or fitting, the gasket and the drilled holes in the strap support.

27. Install shakeproof washers and hexagon nuts on the machine screws. See Fig. 16.

28. Tighten nuts with an end wrench while holding the machine screws with a screw driver.

B. For the Smaller Fixture or Fitting

16. Template base of fixture or fitting to be mounted.

17. Measure the vertical distance between the outside edges of the strap supports.

18. Select a piece of 1/8" steel plate that will be approximately 1" wider than the base of the fixture or fitting and long enough to satisfy the dimension obtained in Step 17.

19. Cut the plate to suit the dimensions determined in Step 18, using the bench shears, and remove sharp edges with a file.

20. Center the template of the fixture or fitting on the plate and mark and center punch the locations of mounting holes on the plate.

21. Measure 5/8" from all sides of the plate and scribe lines parallel to the sides for the full length and width of the plate.

22. Center punch and drill 3/8" holes in the plate at the intersections of the lines scribed in Step 21.

23. Drill holes in the plate for machine screws suitable for supporting the fixture or fitting, at the points center punched in Step 20.

24. Spot and center punch the locations of the mounting holes for the plate on the strap supports, using the plate as a template.

25. Drill 3/8" holes through the strap supports at the locations determined in Step 24.

26. Install 5/16"-18 round head machine screws (5/8" long) through the mounting holes of the plate and the drilled holes in the strap supports and install shakeproof washers and hexagon nuts thereon. See Fig. 16.

27. Install suitable round head machine screws through the mounting holes of the fixture or fitting and the holes drilled in Step 23 and install hexagon nuts thereon.

28. Spot locations at which cables are to penetrate the fixture or fitting and mark with chalk or crayon.

29. Remove fixture or fitting from the strap supports and drill and tap for terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

30. Paint surfaces of plate and bottom of fixture or fitting that are to butt, with one coat of zinc chromate primer.

31. Cut a canvas or canton flannel gasket, using the base of the fixture or fitting as a template.

32. Impregnate gasket with zinc chromate primer.

Note: Where material is to be left bright, or where fixture or fitting is of the molded phenolic type, the gasket and the contact surfaces (Step 30) are painted with a spar varnish of the phenolic type.

33. Insert gasket between fixture or fitting and the plate.

34. Insert suitable round head machine screws through the mounting holes of the fixture or fitting, through the gasket and the drilled holes in the plate.

35. Install shakeproof washers and hexagon nuts on the machine screws.

36. Tighten all nuts with an end wrench while holding the machine screws with a screw driver.

METHOD JJ

METHOD OF SECURING LARGE PANEL OR BOX TO STEEL W. T. BULKHEAD (REQUIRING MOUNTING BOLTS LARGER THAN 5/16" D.)

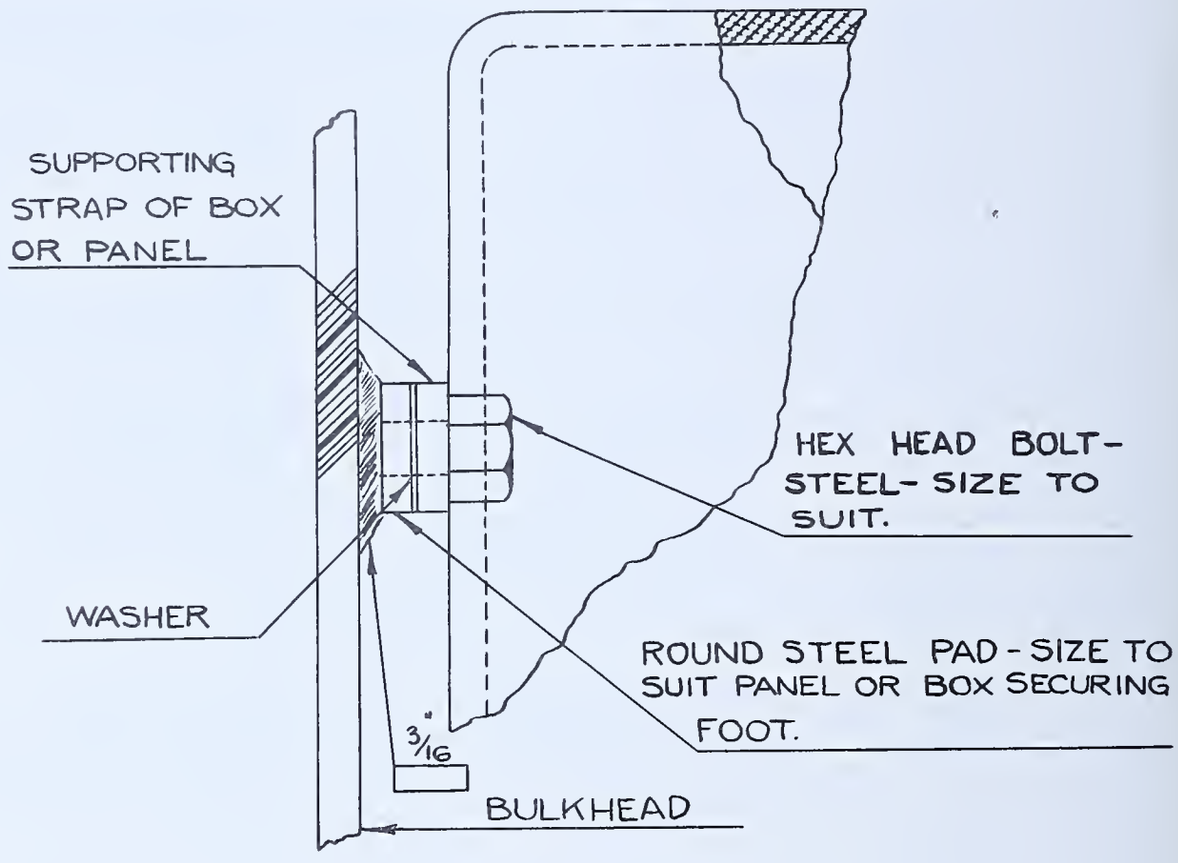

SUPPORTING STRAP OF BOX OR PANEL
HEX HEAD BOLT- STEEL- SIZE TO SUIT.
WASHER
ROUND STEEL PAD - SIZE TO SUIT PANEL OR BOX SECURING FOOT.
3/16"
BULKHEAD

FIG.-18

1. Determine number of mounting holes in panel or box to be mounted.

2. Draw from stock suitable round steel pads with drilled and tapped holes to suit mounting bolts intended to support the panel or box. The number of pads required was determined in Step 1.

   Note: The size of the mounting bolt is determined by the drilled holes in the supporting strip of the panel or box to be mounted.

3. Instruct welder to weld one pad to the bulkhead in the desired location. See Fig. 18.

4. Install hexagon head steel bolt of suitable size and length through the desired hole in the supporting strap of the panel or box and into the tapped hole of the pad on the bulkhead.

5. Install suitable hexagon head steel bolts through the remainder of the holes in the mounting straps and into the tapped holes of pads.

6. Hold the panel or box in a level position and have welder tack weld pads (Step 5) to the bulkhead.

7. Remove the mounting bolts and the panel or box from the pads and have welder fillet-weld the pads all around as shown in Fig. 18.

8. Remount the panel or box and spot locations at which cables are to penetrate panel or box and mark with chalk or crayon.

9. Remove the panel or box from the pads and have holes drilled for terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

10. Cut canvas or canton flannel washers using the pads as templates.

11. Impregnate washers with zinc chromate primer.

12. Insert washers between supporting straps and pads.

13. Install shakeproof washers on the hexagon head bolts.

14. Insert the bolts through the mounting holes, the washers and into the tapped holes of the pads.

15. Tighten bolts with an end wrench.

METHOD KK

METHOD OF SECURING LARGE PANEL OR BOX TO STEEL N. W. T. BULKHEAD (REQUIRING MOUNTING BOLTS LARGER THAN 5/16" D.)

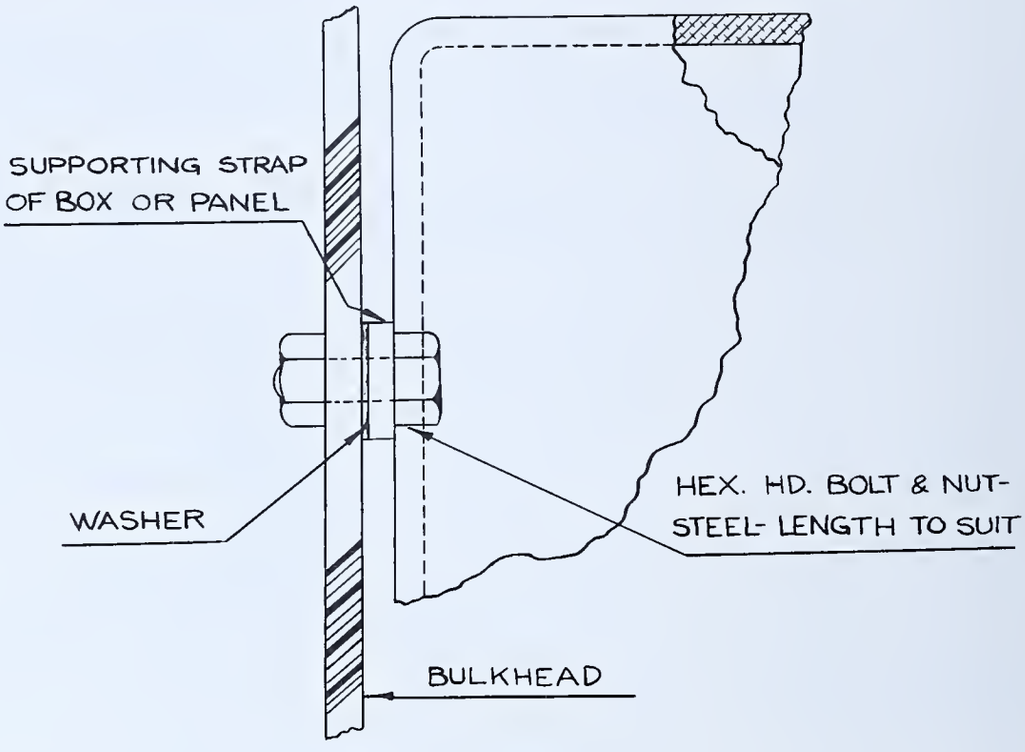


FIG.-19

1. Template mounting holes from supporting strap of box or panel to be mounted.

2. Spot and center punch centers of mounting holes in the desired location on the bulkhead, using the template.

3. Have holes drilled in bulkhead the same size as the mounting holes in the panel or box.

4. Insert suitable hexagon head steel bolts through the mounting holes of the panel or box and through the holes in the bulkhead and install hexagon nuts thereon.

5. Spot locations at which cables are to penetrate panel or box and mark with chalk or crayon.

6. Remove panel or box from bulkhead and have holes drilled for terminal tubes or cable clamps, as outlined in Units 11 or 14, respectively.

7. Paint surface of bulkhead where supporting straps of panel or box are to butt and the bottom of the supporting straps with one coat of zinc chromate primer.

8. Cut canvas or canton flannel washers, using the ends of the supporting straps of the panel or box as templates. See Fig. 19.

9. Impregnate washers with zinc chromate primer.

   Note: Where material is to be left bright, the washer and the contact surfaces (Step 7) are painted with spar varnish of the phenolic type.

10. Insert washers between mounting strap of panel or box and bulkhead. See Fig. 19.

11. Insert hexagon head bolts through the mounting holes of the panel or box, through the washers and into the holes in the bulkhead.

12. Install shakeproof washers and hexagon nuts on bolts. See Fig. 19.

13. Tighten the nuts with an end wrench.

METHOD CD

METHOD OF SUPPORTING LARGE PANELS OR BOXES TO STEEL W.T.

AND N. W. T. BULKHEADS (Alternate for Methods JJ and KK)

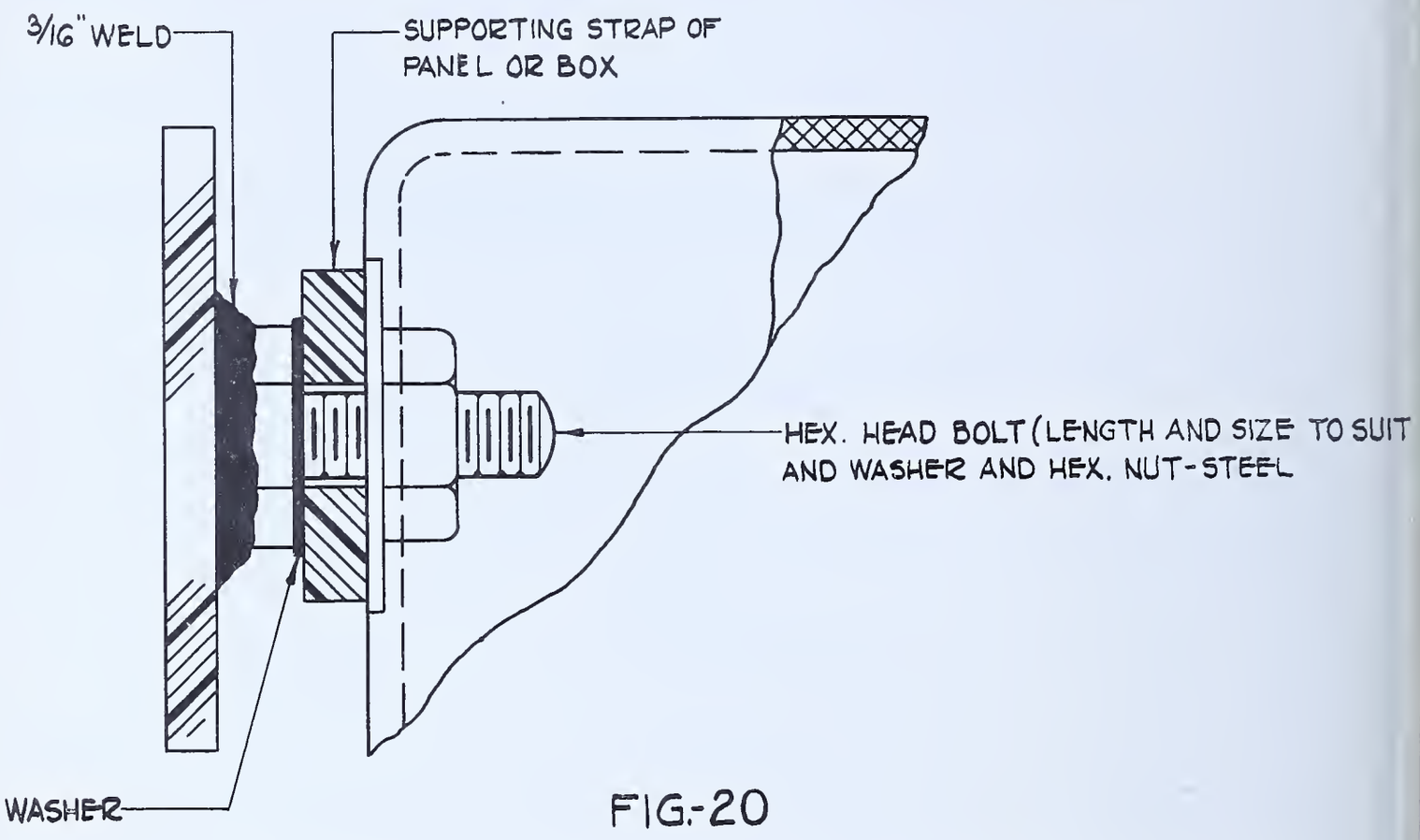


FIG.-20

1. Determine number and size of mounting holes on panel or box to be mounted.

2. Draw from stock suitable steel hexagon head bolts (threaded full length), washers and hexagon nuts to suit mounting holes on panel or box.

   Note: Length of the bolt is determined by thickness of mounting strap, washer and nut. See Fig. 20.

3. Instruct welder to weld one bolt head to the bulkhead in the desired location. See Fig. 20.

4. Support panel or box on bolt welded on bulkhead, using the desired hole in mounting strap, and install a hexagon nut on the bolt.

5. Install a bolt through each mounting hole (from the back of the panel or box) and install hexagon nuts thereon. See Fig. 20.

6. Hold panel or box in a level position and have welder tack-weld bolt heads (Step 5) to the bulkhead.

7. Remove hexagon nuts and panel or box from bolts and have welder fillet weld bolt heads all around as shown in Fig. 20.

8. Remount the panel or box and spot locations at which cables are to penetrate panel or box, and mark with chalk or crayon.

9. Remove fixture from pads and have holes drilled for terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

10. Cut canvas or canton flannel washers using the heads of the bolts as templates.

11. Impregnate washers with zinc chromate primer.

12. Insert washers on bolts. See Fig. 20.

13. Remount panel or box on bolts and install washers and hexagon nuts on the bolts. See Fig. 20.

14. Tighten nuts with an end wrench.

METHOD EEL

METHOD OF SECURING FIXTURE OR FITTING

TO ALUMINUM DECK OR W. T. BULKHEAD

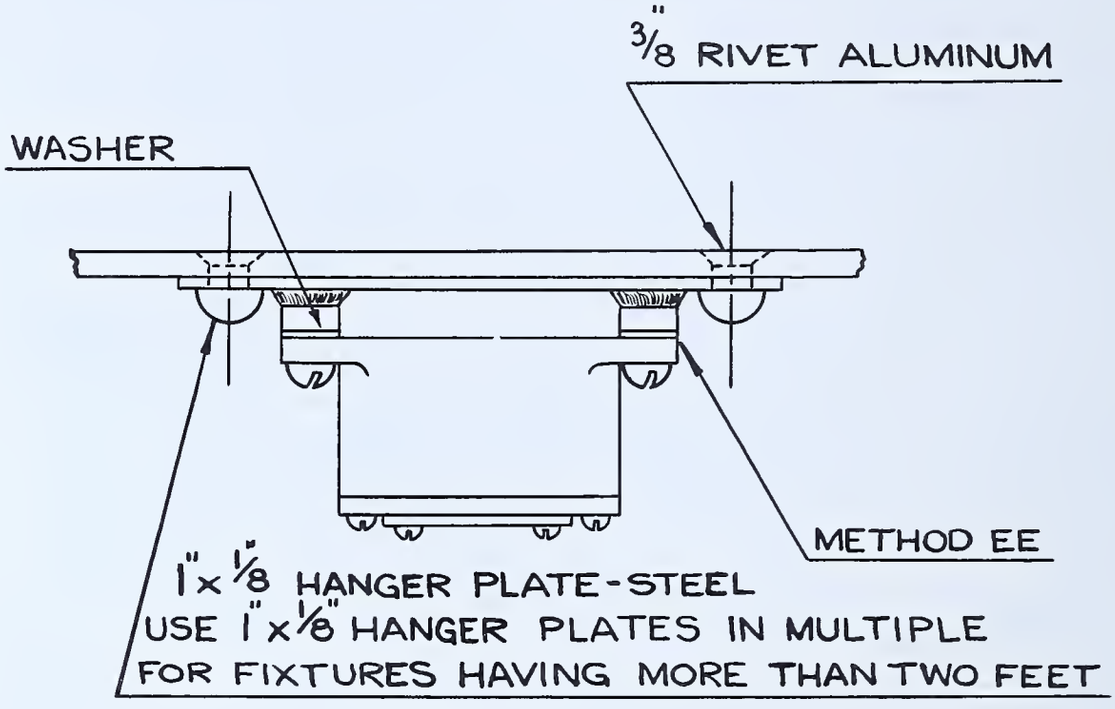


FIG.-21

1. Measure base of fixture or fitting to be mounted (outside dimension).

2. Determine length of the hanger plate (dimension obtained in Step 1 plus 2-1/2").

   Note: The 2-1/2" is to allow 1-1/4" on either side of the fixture or fitting for the aluminum rivets and to clear the weld. See Fig. 21.

3. Determine the number of mounting holes in the fixture or fitting to be mounted.

4. Select a piece of 1" x 1/8" strap steel to suit the length determined in Step 2.

   Notes: (a) Fixtures or fittings having two mounting holes require only one hanger plate.

   (b) Fixtures or fittings having more than two mounting holes require a hanger plate for each set of holes.

5. Scribe a line at right angles to the side of the hanger material, close to one end, using a square.

6. Mark off dimension obtained in Step 2, starting at the line scribed in Step 5 and scribe a line at right angles to the side using a square.

7. Cut both ends along the scribed lines (Steps 5 and 6) using the bench shears.

8. Measure 1/2" from each end of the hanger and scribe lines perpendicular to the sides.

9. Measure to the center of the hanger material along the scribed lines (Step 8) and scribe lines parallel to the side.

10. Center punch and drill hanger material at intersection of scribed lines (Steps 8 and 9) for 3/8" aluminum rivet.

11. Spot and center punch holes of hanger in the desired location on aluminum deck or bulkhead, using the hanger as a template.

12. Have holes drilled in deck or bulkhead for 3/8" aluminum rivets.

13. Have driller countersink opposite side of deck or bulkhead to suit flat head aluminum rivets. See Fig. 21.

14. Insert 3/8" round head machine screws through the holes in the hanger plate and bulkhead or deck and install hexagon nuts thereon.

15. Draw from stock, 5/8" D. x 3/8" steel pads with drilled and tapped holes to suit machine screws intended to support the fixture or fitting. The number of pads required was determined in Step 3.

    Note: The size of the screw is determined by the size of the mounting holes in the fixture or fitting to be mounted.

16. Install suitable round head machine screws through the mounting holes of the fixture or fitting and into the tapped hole of the pads.

17. Hold the fixture or fitting against the hanger plate on the bulkhead or deck and have welder tack weld pads. See Fig. 21.

18. Remove machine screws and fixture or fitting from the pads.

19. Remove machine screws, hexagon nuts and hanger plate from the deck or bulkhead.

20. Have welder fillet-weld pads all around to the hanger plate as shown in Fig. 21.

21. Insert flat head aluminum rivets through the holes in the deck or bulkhead and the holes in the hanger plate.

22. Round off the head of rivets using a rivet set.

23. Insert round head machine screws through the mounting holes of the fixture or fitting and into the tapped hole in the pads.

24. Spot locations at which cables are to penetrate the fixture or fitting and mark with chalk or crayon.

25. Remove fixture from pads and have holes drilled for terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

26. Paint surface of pad and bottom of fixture or fitting (where pad is to butt) with one coat of zinc chromate primer.

27. Cut canvas or canton flannel washers using the pads as templates.

28. Impregnate washers with zinc chromate primer.

Note: Where material is to be left bright or where fixture or fitting is of the molded phenolic type, the washer and the contact surfaces (Step 26) are painted with spar varnish of the phenolic type.

29. Insert washers between fixture or fitting and pads. (See Fig. 21)

30. Install shakeproof washer on each round head machine screw.

31. Insert machine screws through the mounting holes of the fixture, through the washers and into the pads.

32. Tighten screws with a screw driver.

METHOD FFL

METHOD OF SECURING FIXTURE OR FITTING

TO N. W. T. ALUMINUM BULKHEAD

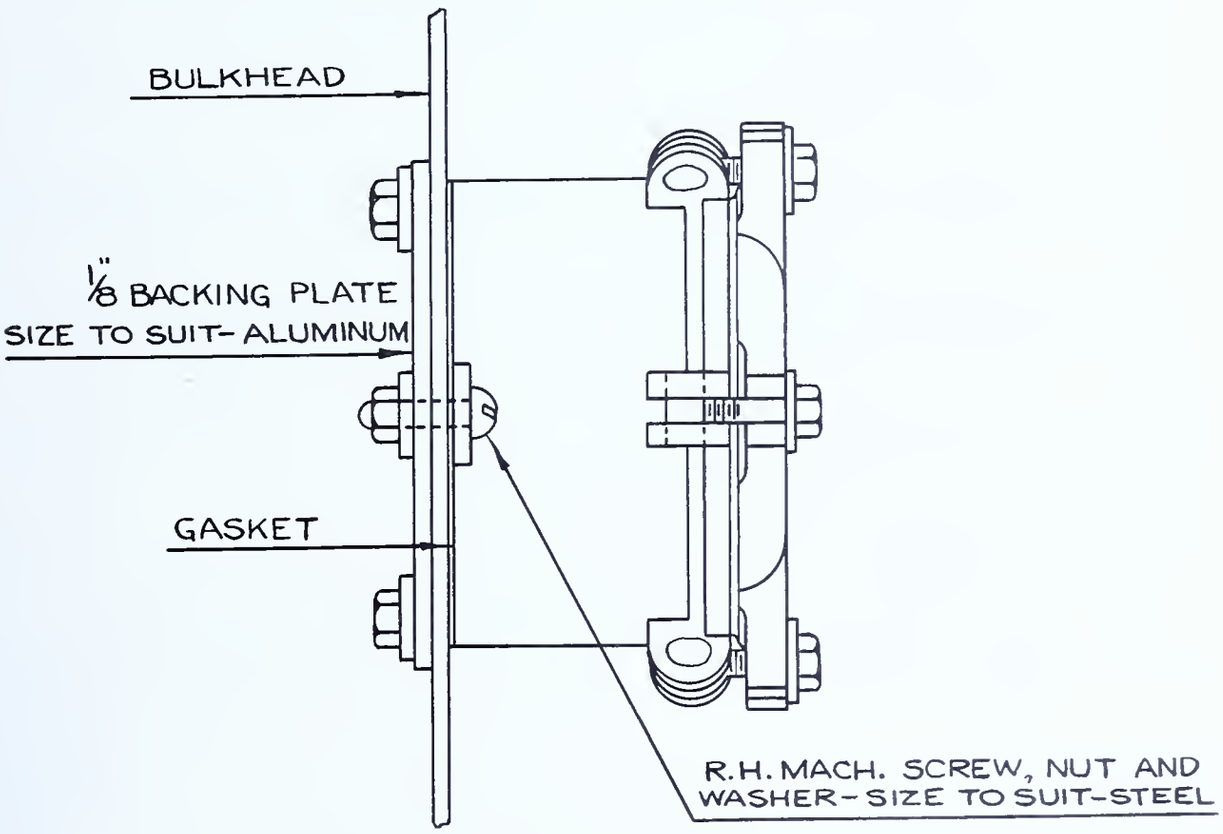


FIG.-22

1. Template base of fixture or fitting to be mounted.

2. Spot and center punch centers of mounting holes in the desired location and position on the bulkhead, using the template.

3. Have holes drilled in bulkhead the same size as the mounting holes in the fixture or fitting.

4. Select a piece of 1/8" aluminum plate that will be 3/8" larger (all around) than the template (Step 1).

5. Trim the plate to a dimension 3/8" larger (all around) than the template, using the bench shears.

6. Grind edges of plate smooth on the emery wheel.

7. Spot, center punch and drill mounting holes in the plate, using the template.

8. Insert suitable round head machine screws through the mounting holes in the fixture or fitting and through the holes in the bulkhead and install hexagon nuts thereon.

9. Spot locations at which cables are to penetrate fixture or fitting and mark with chalk or crayon.

10. Remove fixture or fitting from bulkhead and have holes drilled for terminal tubes or cable clamps, as outlined in Units 11 or 14, respectively.

11. Paint surface of bulkhead where the fixture is to butt and the bottom of the fixture or fitting with one coat of zinc chromate primer.

12. Cut a canvas or canton flannel gasket, using the base of the fixture or fitting as a template.

13. Impregnate gasket with zinc chromate primer.

    Note: Where material is to be left bright, or where fixture or fitting is of the molded phenolic type, the gasket and the contact surfaces (Step 11) are painted with spar varnish of the phenolic type.

14. Insert gasket between fixture or fitting and bulkhead. See Fig. 22.

15. Insert round head machine screws through the mounting holes of the fixture or fitting, the gasket, the bulkhead and the backing plate. See Fig. 22.

16. Install flat washers, shakeproof washers, and hexagon nuts on the machine screws. See Fig. 22.

17. Tighten nuts with end wrench while holding machine screws with screw driver.

METHOD CCL

METHOD OF SECURING FIXTURE OR FITTING TO ALUMINUM DECK OR BULKHEAD - W. T. AND N. W. T. - EXTENSION

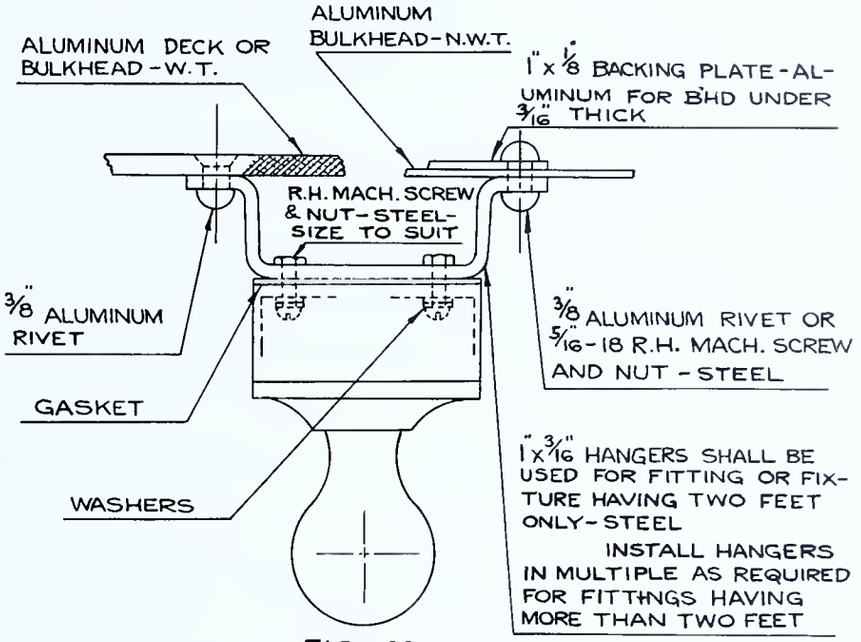

ALUMINUM DECK OR BULKHEAD - W.T.
ALUMINUM BULKHEAD - N.W.T.
1" x 1/8 BACKING PLATE - ALUMINUM FOR BHD UNDER 3/16" THICK
R.H. MACH. SCREW & NUT - STEEL - SIZE TO SUIT
3/8" ALUMINUM RIVET
GASKET
WASHERS
3/8" ALUMINUM RIVET OR 5/16 - 18 R.H. MACH. SCREW AND NUT - STEEL
1" x 3/16 HANGERS SHALL BE USED FOR FITTING OR FIXTURE HAVING TWO FEET ONLY - STEEL
INSTALL HANGERS IN MULTIPLE AS REQUIRED FOR FITTINGS HAVING MORE THAN TWO FEET

FIG.-23

1. Measure distance from deck or bulkhead required to clear wiring or other obstruction. See Fig. 23.

2. Measure distance required to span wiring or obstruction (dimension not be less than diameter of fixture plus 1/2").

   Note: The 1/2" is to permit 1/4" on each side for clearance.

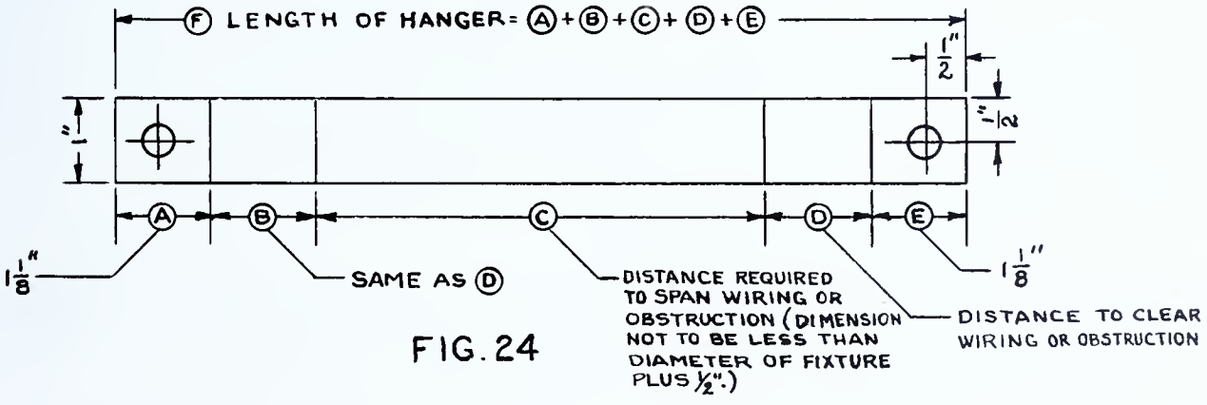

F LENGTH OF HANGER = A + B + C + D + E
1/2"
1"
A
B
C
D
E
1 1/8"
SAME AS D
DISTANCE REQUIRED TO SPAN WIRING OR OBSTRUCTION (DIMENSION NOT TO BE LESS THAN DIAMETER OF FIXTURE PLUS 1/2".)
DISTANCE TO CLEAR WIRING OR OBSTRUCTION
1 1/8"

FIG. 24

3. Determine the length of the hanger material (dimension F of Fig. 24).

4. Determine the number of mounting holes in the fixture or fitting.

5. Select a piece of 1" x 3/16" strap steel to suit the length determined in Step 3.

Notes: (a) Fixtures or fittings having two mounting holes or mounting feet require only one hanger.

(b) Fixtures or fittings having more than two mounting holes or mounting feet require a hanger at each set of holes.

6. Scribe a line at right angles to the side of the hanger material, close to one end, using a square.

7. Mark off dimension obtained in Step 3, starting at the line scribed in Step 6 and scribe a line at right angles to the side, using a square.

8. Cut both ends along the scribed lines (Steps 6 and 7), using the bench shears.

9. Mark off dimension A and E (Fig. 24) and scribe lines perpendicular to the side.

10. Mark off dimensions B and D (Fig. 24) and scribe lines perpendicular to the sides.

11. Bend material along the scribed lines (Steps 9 and 10) in the direction shown in Fig. 23.

12. Template and drill mounting holes in hanger to suit fixture or fitting used.

13. Measure 1/2" from each end of the hanger and scribe lines parallel to the sides.

14. Measure to center of hanger material along the scribed lines (Step 13) and scribe lines parallel to the side.

15. Center punch and drill hanger material at intersection of scribed lines (Steps 13 and 14) for 3/8" aluminum rivet.

16. Template holes on back of hanger.

17. Spot and center punch holes of hanger on aluminum deck or bulkhead.

18. Have holes drilled in deck or bulkhead for 3/8" aluminum rivets.

A. For Watertight Bulkheads:

19. Have driller countersink opposite side of deck or bulkhead to suit flat head aluminum rivets. See Fig. 23.

20. Insert flat head aluminum rivets through the holes in the deck or bulkhead and the drilled holes in the hanger.

21. Round off the head of rivets using a rivet set.

(Proceed with Step 22 below)

B. For Non-watertight Bulkheads Under 3/16" Thick:

19. Make 1" x 1/8" backing plate (aluminum), using the back of the hanger as a template. See Fig. 23.

20. Insert 3/8" round head aluminum rivets through the holes in the backing plate, the bulkhead and the hanger.

21. Round off the head of rivets using a rivet set.

Note: 5/16"-18 round head steel machine screws and hexagon nuts may be installed in place of the rivets.

22. Insert suitable round head machine screws through the mounting holes of the fixture and through the holes in the hanger, and install hexagon nuts thereon.

23. Tighten nuts hand-tight.

24. Spot locations at which cables are to penetrate the fixture and mark with chalk or crayon.

25. Remove fixture from hanger and have holes drilled for terminal tubes or cable clamps.

26. Paint surface of hanger and fixture or fitting (where they are to butt) with one coat of zinc chromate primer.

27. Cut a canvas or canton flannel gasket, using the contact surface of the hanger as a template.

28. Impregnate gasket with zinc chromate primer.

Note: Where material is to be left bright, or where fixture or fitting is of the molded phenolic type, the gasket and the contact surface (Step 19) are painted with spar varnish of the phenolic type.

29. Insert gasket between fixture or fitting and hanger. See Fig. 23.

30. Insert round head machine screws through mounting holes in fixture or fitting and hanger.

31. Install shakeproof washers and hexagon nuts on machine screws.

32. Tighten nuts with an end wrench while holding the screws with a screw driver.

METHOD DDL

METHOD OF SECURING FIXTURE OR FITTING TO W.T.

ALUMINUM DECK OR BULKHEAD HAVING INSULATION

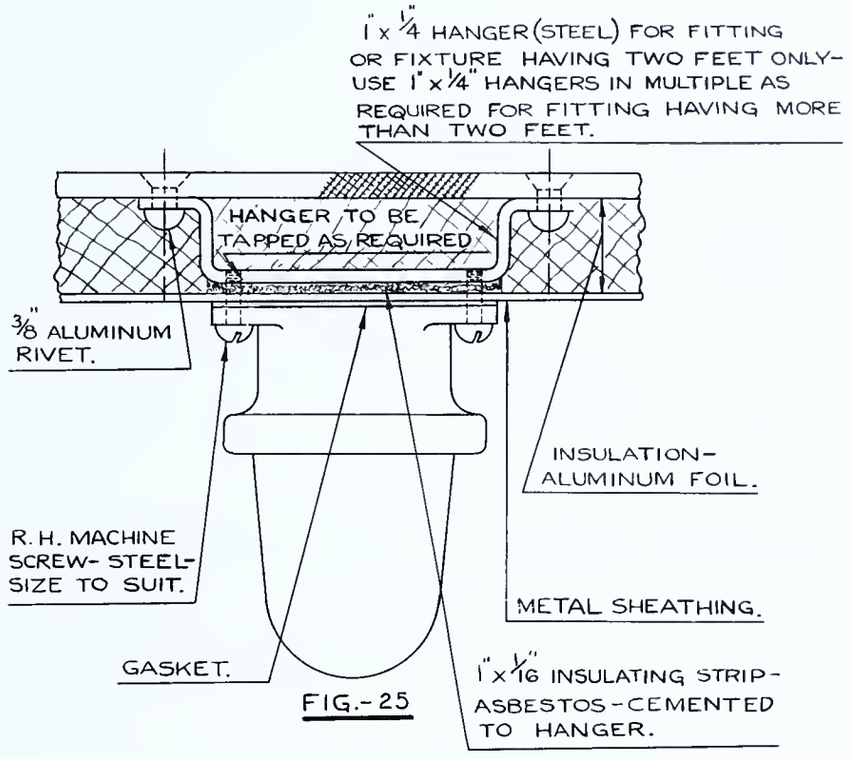

1" x 1/4 HANGER (STEEL) FOR FITTING OR FIXTURE HAVING TWO FEET ONLY- USE 1" x 1/4" HANGERS IN MULTIPLE AS REQUIRED FOR FITTING HAVING MORE THAN TWO FEET.
HANGER TO BE TAPPED AS REQUIRED
3/8" ALUMINUM RIVET.
INSULATION- ALUMINUM FOIL.
R.H. MACHINE SCREW- STEEL- SIZE TO SUIT.
METAL SHEATHING.
GASKET.
1" x 1/16 INSULATING STRIP- ASBESTOS-CEMENTED TO HANGER.

FIG.-25

1. Determine thickness of insulation. See Fig. 25.

2. Measure base of fixture or fitting to be mounted (outside dimension).

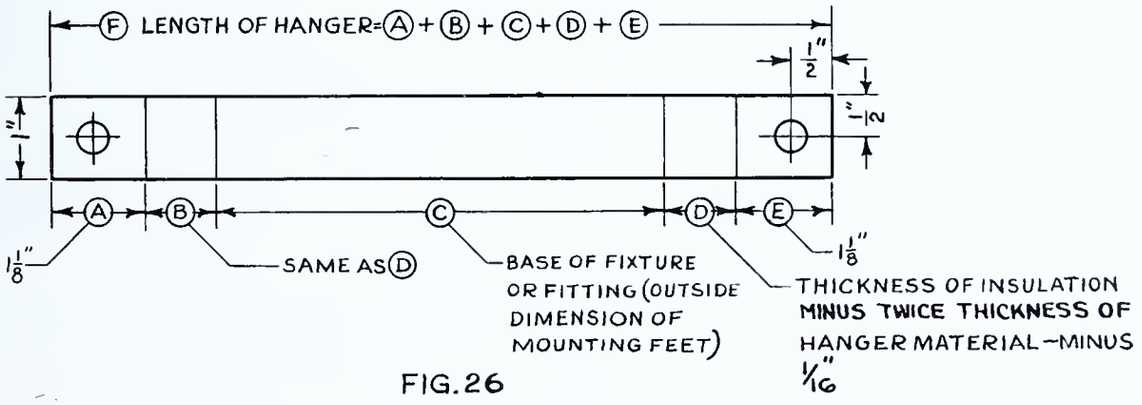


FIG.26

3. Determine the length of the hanger material (dimension F of Fig. 26).

4. Determine number of mounting holes in the fixture or fitting.

5. Select a piece of 1" x 1/4" strap steel to suit the length determined in Step 3.

   Notes: (a) Fixtures or fittings having two mounting holes require only one hanger.

   (b) Fixtures or fittings having more than two mounting holes require a hanger at each set of holes.

6. Scribe a line at right angles to the side of the hanger material, close to one end, using a square.

7. Mark off dimension obtained in Step 3, starting at the line scribed in Step 6, and scribe a line at right angles to the side, using a square.

8. Cut both ends along the scribed lines (Steps 6 and 7), using a hack saw.

9. Mark off dimensions A and E (Fig. 26) and scribe lines at right angles to the side.

10. Mark off dimensions B and D (Fig. 26) and scribe lines at right angles to the side.

11. Bend material along the scribed lines (Steps 9 and 10) in the direction shown in Fig. 25.

12. Template, drill and tap mounting holes in hanger to suit fixture or fitting used.

13. Measure 1/2" from each end of hanger and scribe lines at right angles to the side.

14. Measure to center of hanger material along scribed lines (Step 13) and scribe lines parallel to the side.

15. Center punch and drill hanger material at intersection of scribed lines (Steps 13 and 14) for 3/8" aluminum rivets.

16. Template holes on back of hanger.

17. Spot and center punch holes of hanger on aluminum deck or bulkhead, using the template.

18. Have holes drilled in deck or bulkhead for 3/8" aluminum rivets.

19. Have driller countersink opposite side of deck or bulkhead to suit flat head aluminum rivets. See Fig. 25.

20. Insert flat head aluminum rivets through the holes in the deck or bulkhead and the drilled holes in the hangers.

21. Round off the head of rivets using a rivet set.

22. Insert round head machine screws through the base of the fixture or fitting and through the mounting holes of the fixture or fitting and into the tapped hole in the hanger.

23. Tighten screws with a screw driver.

24. Spot locations at which cables are to penetrate fixture or fitting and mark with chalk or crayon.

25. Remove fixture or fitting from hanger and have holes drilled for terminal tubes or cable clamps as outlined in Units 11 or 14.

26. Cut 1/16" thick asbestos washers, using hangers as templates.

27. Cement a washer to each hanger, using spar varnish or shellac. See Fig. 25.

28. After insulation has been installed, have sheet metal worker template and drill holes in sheathing to permit installation of machine screws.

29. Paint surface of sheathing where fixture is to butt, and bottom of machine screws.

30. Cut a canvas or canton flannel gasket, using the base of the fixture as a template.

31. Impregnate gasket with zinc chromate primer.

    Note: Where material is to be left bright, or where fixture or fitting is of the molded phenolic type, the gasket and the contact surfaces (Step 29) are painted with spar varnish of the phenolic type.

32. Insert gasket between fixture or fitting and sheathing. See Fig. 25.

33. Install a shakeproof washer on each round head machine screw.

34. Insert machine screws through the mounting holes of the fixture or fitting and into the tapped holes of the hanger.

35. Tighten screws with screw driver.

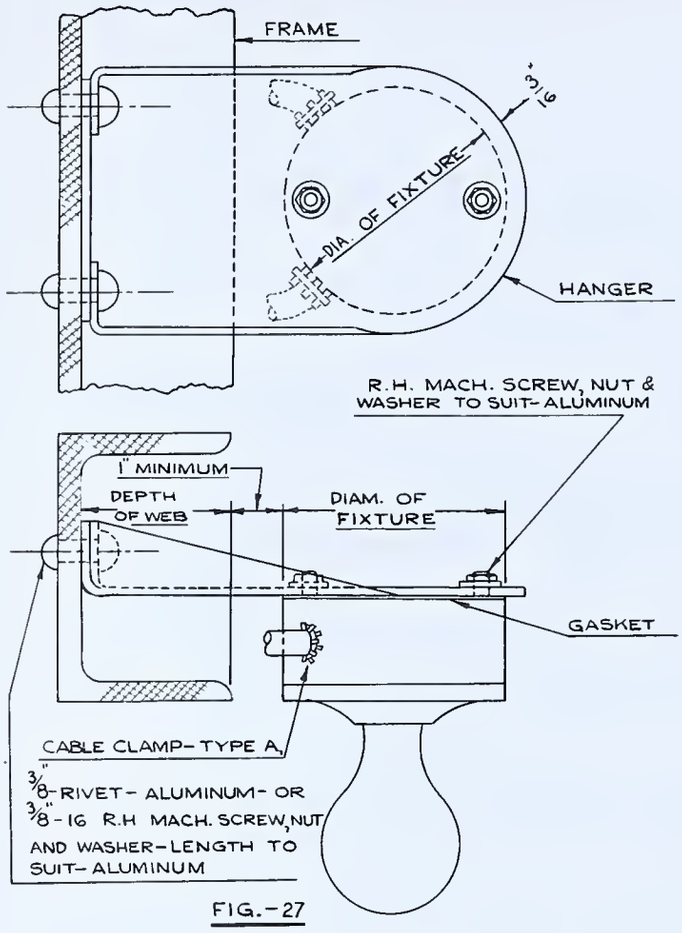


FIG.-27

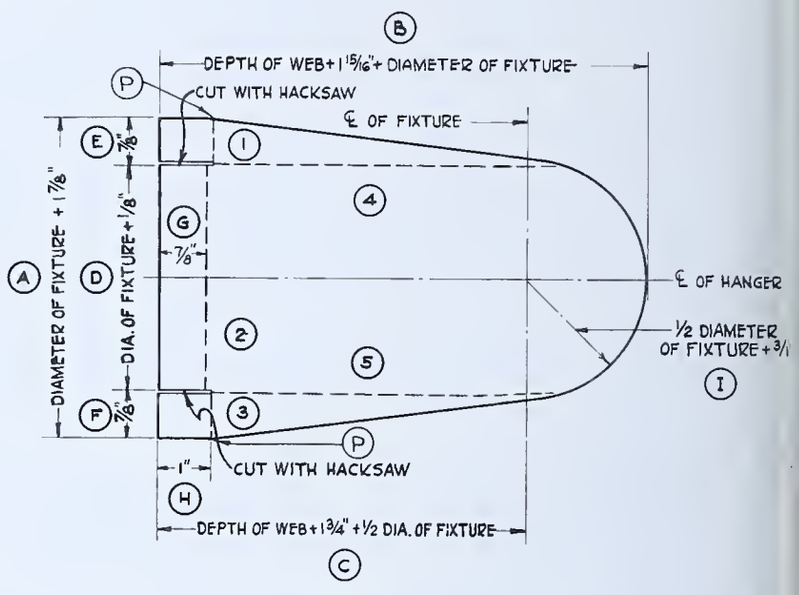


FIG.-28

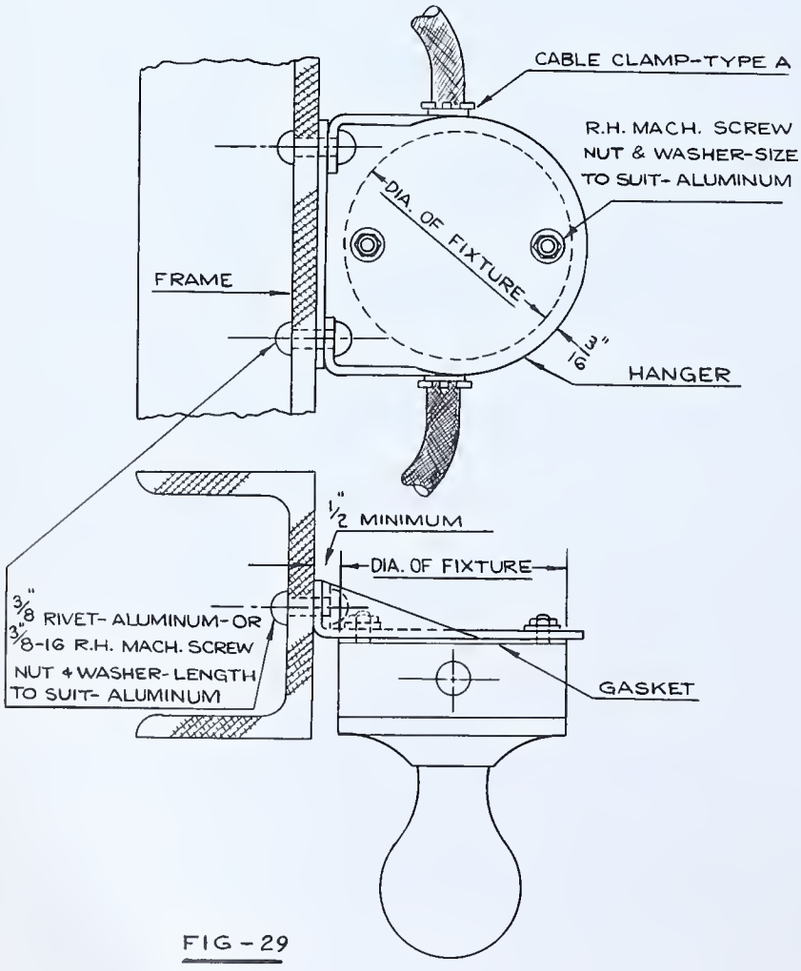


FIG-29

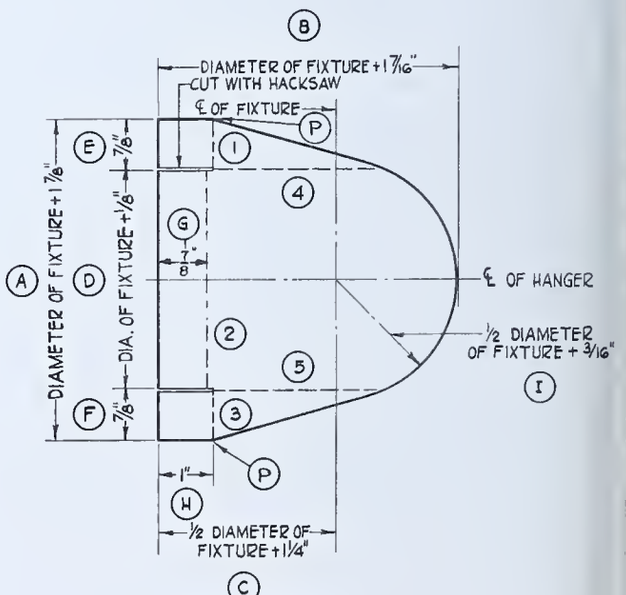


FIG-30

METHOD OF SECURING FIXTURES TO ALUMINUM FRAMES OR LONGITUDINAL

AAL-Inside a Web

BBL-To Face of Structure

The method of securing fixtures to aluminum frames or to the inside of a web aries only in the length of fixture support.

These brackets cannot be welded and so are bolted or riveted in place. Other points of difference from the brackets for steel are: (1) an extra flange against the structure, (2) flanges turned up instead of down, and (3) extension of bracket beyond fixture is 3/16" instead of 1/16".

Follow the sketches carefully in working this unit.

Procedure:

1. Measure diameter of base of fixture.

2. Determine length of hanger (Dimension B).

   AAL Depth of Web + Diameter of Fixture + 1-15/16".*
   *Note: Accept 1-15/16" as arbitrary clearance factor, obtained as follows: Minimum clearance (1"), plus the back of the hanger (1") less approximately twice the thickness of the hanger material (1/4") plus 3/16" clearance beyond the fixture.

   BBL Diameter of Fixture + 1-7/16"**
   **Note: Obtained as follows: Minimum clearance ($\frac{1}{2}$") plus back of hanger (1") less approximately twice the thickness of the hanger material ($\frac{1}{4}$") plus 3/16" clearance beyond fixture.

3. Determine width of hanger material.
   Diameter of fixture + 1/16" side of fixture clearance + combined depth of sides (Figs. 28 and 30, Dimension A).

4. Select piece of .10" sheet aluminum to suit over-all dimensions.

5. Shear straight edge on one end of metal.

6. Locate center on this straight edge.

7. Scribe a line at right angles to edge through this mid point for center line of hanger (Figs. 28 and 30).

8. Determine center line of fixture from straight edge and erect line perpendicular to center line of hanger.

   AAL Depth of Web + 1-3/4"* + Radius of fixture.
   BBL Depth of Web + 1-1/4"* + Radius of fixture.

   *Note: Obtained as follows: Minimum clearance (1" or $\frac{1}{2}$") + back of fixture (1") minus approximately twice the thickness of the hanger material ($\frac{1}{4}$").

9. Set dividers to radius of fixture plus 3/16" clearance and scribe a semi-circle using intersection as center.

10. Mark distance of radius plus 1/16" on straight end, on each side of center line (distance D, Figs. 28 and 30).

11. Scribe lines parallel to center line from each of these points. These will be the bend lines for the sides.

12. Mark off width of hanger, one-half on each side of center line, on the straight end.

13. Scribe lines parallel to center line from these points.

14. Mark off dimension H (Figs. 28 and 30).

15. Scribe lines from these points parallel to straight end. These will be bend lines of corners.

16. Mark off dimension G.

17. Scribe a line parallel to end between the bending lines for sides drawn in Step 11. This line will be the bending line for back of hanger.

18. Scribe lines from intersection of lines made in Steps 12 to 15 (points P), tangent to the semi-circle.

19. Cut around the outer lines, using bench shears.

20. Grind edges smooth on emery wheel.

21. Cut with a hack saw along lines established in Steps 11 and 12 as far as line drawn from H distance.

Note: The hanger is now ready for bending. All bends are made in one direction, using hand brake.

22. Bend along lines 1, 2, 3, 4 and 5 in numerical order. See sketch of hanger in Fig. 31.

DETAIL OF HANGER-ALUMINUM- METHOD AAL.

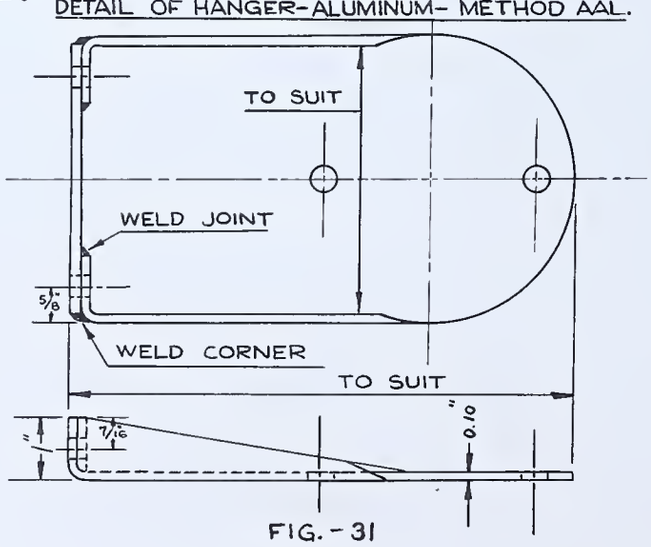


FIG.-31

23. Have corners and joints of the back of hanger fillet-welded. See Fig. 30.

24. Mark and center punch rivet holes on back of hanger, 7/16" from top and 5/8" from sides. See Fig. 31.

25. Drill two 3/8" holes for 5/16" aluminum rivets.

26. Template mounting holes of the fixture.

27. Locate, mark and center punch centers of mounting holes along center-line of hanger. See Fig. 31.

28. Drill mounting holes same size as holes in fixture.

Note: The hanger or "pan" is now complete and ready for mounting.

29. Template holes on back of hanger.

30. Spot and center punch holes of hanger on inside of the aluminum web, using the template.

31. Have 3/8" holes drilled in web at the points center punched.

32. Insert 5/16" aluminum rivets through the holes in the hanger and the holes in the web.

33. Round the rivet heads off, using a rivet set.

Note: 5/16" steel round head machine screws, washers and hexagon nuts may be used in place of the aluminum rivets.

With the hanger in place, it is now possible for the electrician to spot the points where the cable is to penetrate the fixture base.

34. Insert suitable round-head machine screws through the base of the fixture and through the holes in the hanger and install hexagon nuts thereon.

35. Tighten nuts hand-tight.

36. Spot location at which cables are to enter fixture and mark with chalk or crayon.

37. Remove fixture from hanger and have holes drilled for terminal tubes or cable clamps as outlined in Units 11 and 14, respectively.

38. Paint the bottom of the hanger that is to contact the base of the fixture with one coat of zinc chromate primer.

39. Paint bottom of fixture base with one coat of zinc chromate primer.

Note: Where material is to be left bright, the contacting surfaces are painted with spar varnish of the phenolic type instead of the zinc chromate primer.

40. Cut a canvas or canton flannel gasket, using the base of the fixture as a template.

41. Impregnate gasket with zinc chromate primer and allow to dry.

Note: Where molded phenolic fixture is used, the gasket is painted with spar varnish of the phenolic type instead of zinc chromate primer.

42. Place a metal washer on each round head machine screw to be used for mounting the fixture.

43. Insert machine screws through the holes in the base of the fixture, the gasket and the holes in the hanger.

44. Install shakeproof washers and hexagon nuts on the machine screws. See Figs. 27 and 29.

45. Tighten the hexagon nuts with a wrench, holding the machine screws with a screw driver.

METHOD GGL

METHOD OF SECURING FIXTURE OR FITTING

TO CORRUGATED ALUMINUM BULKHEADS

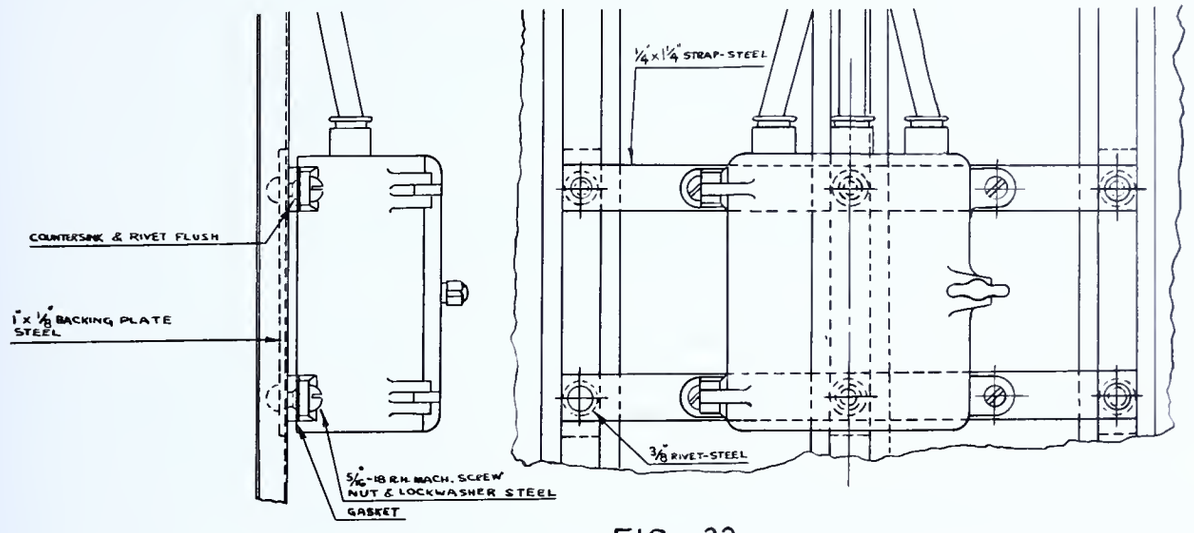
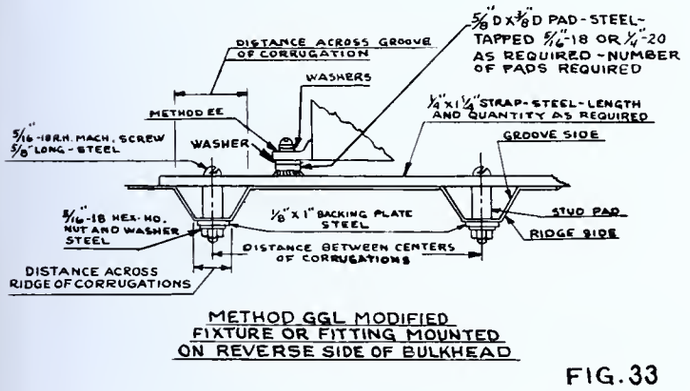
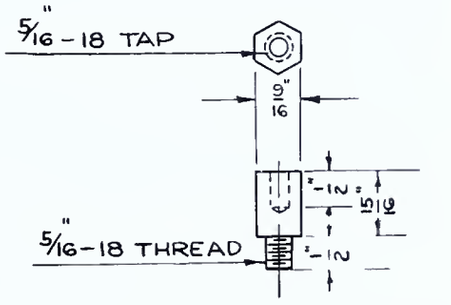


FIG.-32


DISTANCE ACROSS GROOVE OF CORRUGATION
5/8"D X 3/8"D PAD-STEEL-TAPPED 5/16"-18 OR 1/4"-20 AS REQUIRED-NUMBER OF PADS REQUIRED
WASHERS
METHOD EE
1/4"x1 1/4" STRAP-STEEL-LENGTH AND QUANTITY AS REQUIRED
5/16"-18 R.H. MACH. SCREW 5/8" LONG-STEEL
WASHER
GROOVE SIDE
5/16"-18 HEX. HD. NUT AND WASHER STEEL
1/8"x1" BACKING PLATE STEEL
STUD PAD
RIDGE SIDE
DISTANCE BETWEEN CENTERS OF CORRUGATIONS
DISTANCE ACROSS RIDGE OF CORRUGATIONS

METHOD GGL MODIFIED
FIXTURE OR FITTING MOUNTED
ON REVERSE SIDE OF BULKHEAD

FIG.33



STUD PAD STEEL

FIG.-34

A. On the Ridge Side of the Corrugation:

1. Determine the distance between centers of the corrugations. See Fig. 33.

2. Determine the number of corrugations the hanger strap is to span. See Fig. 33.

3. Determine the distance across the ridge of the corrugation. See Fig. 33.

4. Determine the length of the hanger strap material (distance obtained in Step 1 times number of corrugations determined in Step 2 plus distance obtained in Step 3).

5. Determine the number of mounting holes in the fixture or fitting to be mounted.

6. Select a piece of $1\frac{1}{4}$" x $1\frac{1}{4}$" strap steel to suit the length determined in Step 4.

Notes: (a) Fixtures or fittings having two mounting holes require only one hanger strap.

(b) Fixtures or fittings having more than two mounting holes require a hanger strap for each set of holes.

7. Scribe a line at right angles to the side of the hanger material, close to one end, using a square.

8. Mark off dimension obtained in Step 4, starting at the line scribed in Step 7, and scribe a line perpendicular to the side, using a square.

9. Cut both ends along the scribed lines (Steps 7 and 8), using a hack saw.

10. Measure one-half the dimension obtained in Step 3 from each end of the strap material and scribe lines at right angles to the sides.

11. Measure the distance obtained in Step 1 from the line scribed in Step 10 and scribe a line at right angles to the sides.

12. Repeat Step 11 for the number of corrugations determined in Step 2.

13. Locate the center of the strap by measuring 5/8" from the side and scribe a line parallel to the side to intersect the lines scribed in Steps 10, 11 and 12.

14. Center punch and drill strap material for 3/8" steel rivets at intersections determined in Step 13.

15. Mark, center punch and have a 3/8" hole drilled in the bulkhead in the center of one corrugation, in the desired location.

16. Insert a suitable round head machine screw through the hole in one end of the strap material and through the drilled hole in the bulkhead (from the ridge side) and install hexagon nut thereon.

17. Hold hanger in a level position against the bulkhead, mark and center punch the location of the remaining holes in the strap on the bulkhead.

18. Remove strap and have 3/8" holes drilled in bulkhead at points center punched in Step 17.

19. Repeat Steps 15, 16, 17 and 18 to suit each hanger strap determined in Step 6.

20. Insert suitable round head machine screws through the end holes of each strap and through the corresponding holes in the bulkhead, and install hexagon nuts thereon.

21. Hold the fixture or fitting in a level position against the straps and mark location of mounting holes of the fixture or appliance on each strap.

22. Remove, center punch and drill straps for 5/16" machine screws at locations marked in Step 21.

23. Template holes between each hanger strap, along the same corrugation.

24. Determine the length of the backing plate (See Fig. 32) (distance between top and bottom hole plus 2").

    Note: The 2" is to allow 1" of metal beyond center of the top and bottom holes.

25. Select a piece of 1/8" x 1" strap steel to suit the length determined in Step 24.

    Note: A backing plate is required for each corrugation determined in Step 2.

26. Center the template (Step 23) on the backing plate.

27. Mark, center punch and drill 3/8" holes in the backing plate, using the template as a guide.

28. Countersink the holes drilled in the mounting straps (Step 14) for 3/8" buttonhead countersunk rivets.

29. Install 3/8" buttonhead countersunk rivets through countersunk holes (Step 28) of the mounting straps, the corresponding holes in the bulkhead and the backing plates. See Fig. 32.

30. Round off rivet heads, using a rivet set.

31. Install suitable round head steel machine screws through the mounting holes of the fixture or fitting and the drilled holes in the strap, and install hexagon nuts thereon.

32. Spot locations at which cables are to penetrate the fixture or fitting and mark with chalk or crayon.

33. Remove machine screws, nuts, and fixture or fitting, and have fixture or fitting drilled for terminal tubes or cable clamps as outlined in Units 11 and 14, respectively.

34. Paint surface of straps and bottom of fixture or fitting (where strap is to butt) with one coat of zinc chromate primer.

35. Cut canvas or canton flannel gasket $1\frac{1}{4}$" wide, using the base of the fixture or fitting across each pair of mounting holes as the length and the template.

36. Impregnate gaskets with zinc chromate primer.

    Note: Where material is to be left bright, or where fixture or fitting is of the moulded phenolic type, the gaskets and the contact surfaces (Step 34) are painted with spar varnish of the phenolic type.

37. Insert gasket between fixture or fitting and each strap. See Fig. 32.

38. Insert steel round head machine screws through the mounting holes in the fixture or fitting, the gasket and the mounting holes in the straps.

39. Install lock washer and hexagon nut on each machine screw.

40. Tighten nuts with an end wrench while holding machine screws with a screw driver.

B. On the Groove Side of the Corrugation:

1. Determine the distance between centers of the corrugations. See Fig. 33.

2. Determine the number of corrugations the hanger strap is to span. See Fig. 33.

3. Determine the distance across the groove of the corrugation. See Fig. 33.

4. Determine the length of the hanger strap material (distance obtained in Step 1 times number of corrugations determined in Step 2 plus distance determined in Step 3 plus 1").

    Note: The 1" allows $\frac{1}{2}$" overlap on each groove.

5. Determine the number of mounting holes in the fixture or fitting to be mounted.

6. Select a piece of $1\frac{1}{4}$" x $\frac{1}{4}$" strap steel to suit the length determined in Step 4.

    Notes: (a) Fixtures or fittings having two mounting holes require only one hanger strap.

    (b) Fixtures or fittings having more than two mounting holes require a hanger strap for each set of holes.

7. Scribe a line at right angles to the side of the hanger material close to one end, using a square.

8. Mark off dimension obtained in Step 4 starting at the line scribed in Step 7 and scribe a line perpendicular to the side using a square.

9. Cut both ends along the scribed lines (Steps 7 and 8) using a hack saw.

10. Add $\frac{1}{2}$" to one-half the dimension obtained in Step 3, and measure this distance from each end of the strap material and scribe lines at right angles to the sides.

11. Measure the distance obtained in Step 1 from the line scribed in Step 10 and scribe a line at right angles to the sides.

12. Repeat Step 11 for the number of corrugations determined in Step 2.

13. Locate the center of the strap by measuring 5/8" from the side and scribe a line parallel to the side to intersect the lines ccribed in Steps 10, 11 and 12.

14. Center punch and drill strap material for 3/8" steel rivets at intersections determined in Step 13.

15. Mark, center punch and have a 3/8" hole drilled in the bulkhead in the center of one corrugation, in the desired location.

16. Insert a suitable round head machine screw through the hole in one end of the strap material and through the drilled hole in the bulkhead (from the ridge side) and install hexagon nut thereon.

17. Hold hanger in a level position against the bulkhead, mark and center punch the location of the remaining holes in the strap on the bulkhead.

18. Remove strap and have 3/8" holes drilled in bulkhead at points center punched in Step 17.

19. Repeat Steps 15, 16, 17 and 18 to suit each hanger strap determined in Step 6.

20. Insert suitable round head machine screws through the end holes of each strap and through the corresponding holes in the bulkhead, and install hexagon nuts thereon.

21. Draw from stock sufficient quantity of 5/8" Diam. x 3/8" steel pads with drilled and tapped holes to suit machine screws intended to support the fixture or fitting.

22. Install suitable round head machine screws through the mounting holes of the fixture or fitting, and into the tapped hole of the pads.

23. Hold the fixture or fitting in a level position against the straps and have welder tack-weld the pads to the straps.

24. Remove machine screws and fixture or fitting from pads.

25. Remove straps from the bulkhead and have welder fillet-weld pads all around. See Fig. 33.

26. Template holes between each hanger strap, along the same corrugation.

27. Determine the length of the backing plate (See Fig. 32) (distance between top and bottom hole plus 2").

    Note: The 2" is to allow 1" of metal beyond center of the top and bottom holes.

28. Select a piece of 1/8" x 1" strap steel to suit the length determined in Step 27.

    Note: A backing plate is required for each corrugation determined in Step 2

29. Center the template (Step 26) on the backing plate.

30. Mark, center punch and drill 3/8" holes in the backing plate, using the template as a guide.

31. Draw from stock one steel stud pad (Fig. 34) for each hole drilled in the corrugated bulkhead.

32. Insert threaded end of stud pads through holes in bulkhead and the corresponding holes in the backing plate.

33. Install flat steel washer, shakeproof washer, and hexagon head nut on each stud. See Fig. 33.

34. Tighten nuts with an end wrench.

35. Install 5/16"-18 round head steel machine screws (5/8" long) through the holes in the straps and into the tapped holes in the stud pads. See Fig. 33.

36. Tighten machine screws with a screw driver.

37. Install suitable round head machine screws through the mounting holes of the fixture or fitting, and into the tapped holes in the pads on the mounting straps.

38. Spot locations at which cables are to penetrate the fixture or fitting, and mark with chalk or crayon.

39. Remove machine screws and fixture or fitting, and have fixture or fitting drilled for terminal tubes or cable clamps as outlined in Units 11 or 14, respectively.

40. Paint surface of pad and base of fixture or fitting (where pad is to butt) with one coat of zinc chromate primer.

41. Cut canvas or canton flannel washers, using the pads as templates.

42. Impregnate washers with zinc chromate primer.

    Note: Where material is to be left bright, or where fixture or fitting is of the molded phenolic type, the washers and contact surfaces (Step 40) are painted with spar varnish of the phenolic type.

43. Insert washer between fixture or fitting and each pad. See Fig. 33.

44. Install shakeproof washers and flat steel washers on suitable round head machine screws and insert machine screws through mounting holes of fixture, through washer and into the tapped holes of the pads. See Fig. 33.

45. Tighten round head machine screws with a screw driver.

QUESTIONS

Place the answers to these questions in your notebook or on form as directed by instructor.

1. How are fixtures or fittings secured to web frames and longitudinals?

2. How are fixtures or fittings secured to stanchions?

3. (a) Name three methods of supporting fixtures or fittings to steel decks and bulkheads (without insulation).

   (b) Outline the procedure of one method.

4. Outline method of installing fixture or fitting to steel deck (with insulation) using stools.

5. Name three methods of supporting fixtures or fittings to aluminum decks or bulkheads (without insulation).

6. Explain briefly the method of mounting a fixture or fitting on a wire mesh bulkhead.

7. How are fixtures or fittings supported to a wireway?

8. How are fixtures mounted on a deck to avoid obstructions?

9. How are the faying surfaces of decks, bulkheads and fixtures or fittings of dissimilar metals prepared before mounting?

10. (a) What types of gaskets or washers are installed?

    (b) Where are they installed?

11. How high are fixtures, fittings, controllers, panels, etc. mounted from the deck? What must be kept in mind while mounting panels controllers and similar apparatus?

12. Under what conditions may distribution boxes or connection boxes be mounted on the overhead?

13. What must be kept in mind when selecting hanger or support material?

METHODS OF SUPPORTING CABLES TO VARIOUS TYPE DECKS AND BULKHEADS USING STRAPS AND HANGERS

General Information:

The following methods are derived from U. S. Navy Bureau of Ships drawing 9-S-3980-L and indicate supports for single cables, single and multiple rows of cables.

All fixed cables installed on Naval and commercial vessels are rigidly secured by means of cable straps and hangers. Wherever practicable, to conserve space and materials, cables running in a common direction are grouped together.

These groupings of cables are referred to as "cable runs". The U. S. Navy prohibits the installation of flameproof and non-flameproof cables in the same cable racks, on naval vessels, and specifies that as wide a separation as practicable shall be maintained between flameproof and non-flameproof cable installations.

Cable runs are supported to decks and bulkheads approximately every 16" by steel or aluminum straps or hangers. The complete run of straps or hangers is referred to as a "wireway". On new construction, wireways are installed before insulation is in place on decks and bulkheads and before cables are pulled in.

Note: When installing cable, the electrician should be careful to eliminate kinks and twists before securing under strap hangers.

The following directives concerning locations of cable runs and wireways should be thoroughly reviewed by the trainee and followed carefully wherever practicable.

A. All cables shall be run as directly as practicable, parallel to decks and bulkheads, (eliminating diagonal runs).

B. Wireways and cable runs are to be so located and arranged that the cables will not be disturbed by disassembly and removal of machinery.

C. Cable runs are not to be installed in locations where the cable will be subjected to excessive heat. However, if such locations must be selected, heat and flameproof cable shall be installed.

D. Cables are not to be installed adjacent to pipe lines or apparatus which may cause damage to cable due to leaks or sweating. Where these conditions are unavoidable, a drip-proof protection shield shall be installed over the cable runs.

E. Runs of permanently installed cables shall be supported in wireways on bulkheads, except where otherwise specified, in preference to overhead runs on the underside of decks.

F. Wireways in compartments and passages should be located at least 3" away from the adjoining bulkhead or overhead, to afford access for working and cleaning in the vicinity of the wireway.

G. Cable hangers shall have no sharp edges.

H. In welding pads to ship's structure, the hangers which the pads are intended to support may be used as a jig for locating the pads. The pads shall first be tack-welded to obtain correct alignment and spacing, after which the hanger shall be removed and the pads permanently welded.

I. All welding shall be kept clear of butt straps, seams, rivets and caulking edges.

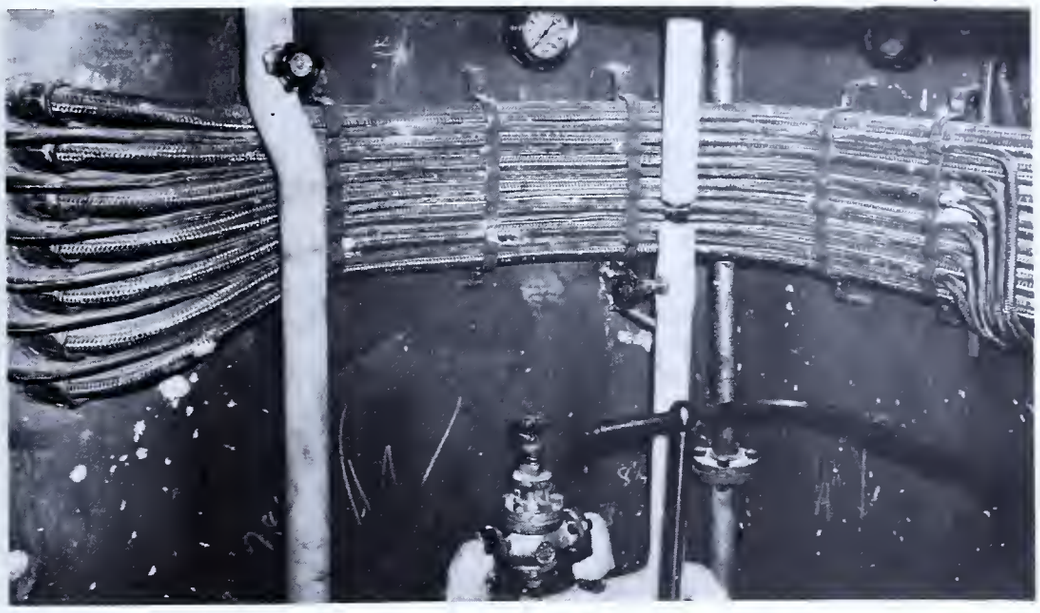
J. All steel cable hanger material shall be black steel, and shall be painted after forming or welding, and again after installation.

K. Electric cables shall not be secured directly to the outer hull plating.

L. Bends in cable runs and wireways shall be based on the minimum bending radius of the largest cable and its relative location in the cable run.

M. Where cables are run in a straight line, a chalk line should be used for marking wireway support limits.

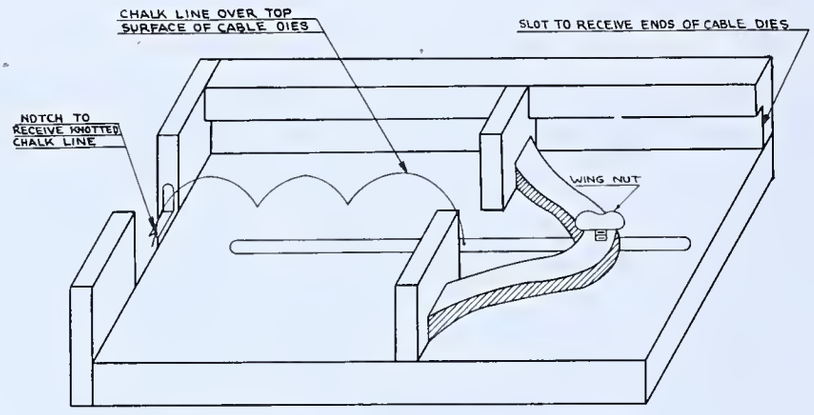
"Chalk lines" are commonly used for striking lines for rivets, pads, or supports for wireway runs. A "chalk line" is a length of cord or twine that has been coated with chalk for its entire length. To strike a line, it is necessary to stretch the chalk line tightly, secure both ends to the deck or bulkhead to be marked, pull the center of the line away from the deck or bulkhead, then release it, allowing the line to snap back.



CABLE RUNS

General Information:

There are various devices for bending straps. Figure 1 illustrates a device for measuring the length of strap used and Figs. 4 A and B, a strap forming "machine" used in some production shops.



DEVICE FOR MEASURING LENGTH OF STRAP REQUIRED

FIG. 1

How to Make Strap Hangers:

Tools:

Hammer, 12 to 24 oz.
Chisel, cable-forming

Equipment:

Strap-bending jig
Cable dies

Materials:

5/8" x 3/32" M. W. Steel, for spans up to 6"
5/8" x 1/8" M. W. Steel, for spans 6" - 9"

Procedure:

Arrange cable forming dies:

1. Sketch the arrangement of cables as they will appear in the finished run. See Fig. 2.

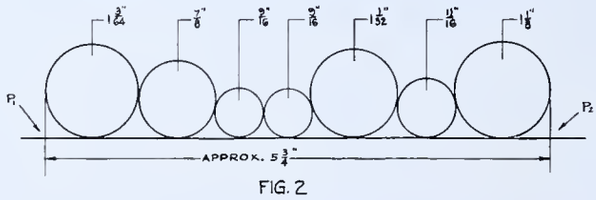


FIG. 2

2. Secure cable dies whose outside diameters are as close as possible to the cables to be used.

   Note: Cable dies are usually obtainable in increments of 1/16" starting at 3/8" diameter.

3. Lay the dies on a level surface, side by side to correspond to the sequence in sketch made in Step 1. Block them at each end to keep from rolling while measuring. Several devices can be developed for this purpose. See Fig. 1.

Measure length of strap required:

4. Hold one end of a short piece (approx. 12") of chalk line at point P_1. See Fig. 2.

5. For the chalk line over the tops of the cable dies by pressing the fingers on the string, following their top contour carefully to Point P_2. Do not permit the string to slip.

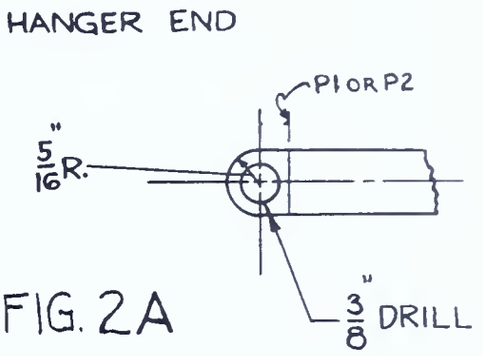


FIG. 2A

6. Hold the line at Point P_2 with the thumb and forefinger to "mark" the distance, and remove cord from the cable dies.

7. Measure the length of cord to Point P_2.

8. Add $1\frac{1}{4}$" (5/8" for each end of strap) to this distance, to allow for "ears".

9. Obtain a piece of strap metal this length and form end as shown in Fig. 2A.

   Note: In some yards these are available in increments of 1/8" having holes already punched and ends rounded.

Bend end or "ear" of strap

10. Place end of strap material in proper slot of strap bender. See Fig. 3A.

11. Pull handle of bender against strap until the strap is flat against block. This forms the ear at P_1.

Form strap

12. Place the dies in proper sequence in the forming jig and block them in place. See Fig. 4A.

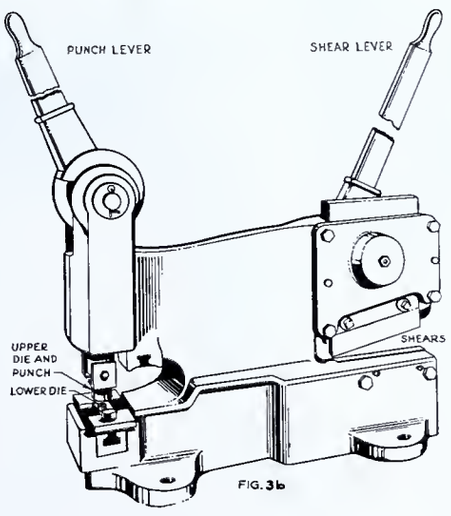


FIG. 3b

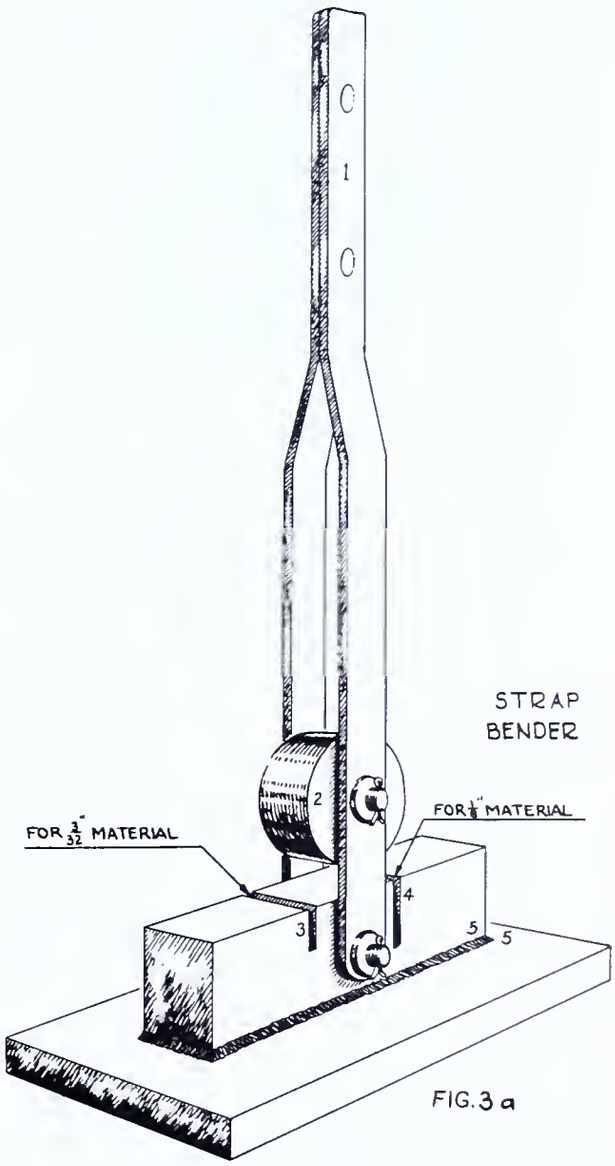


FIG. 3a

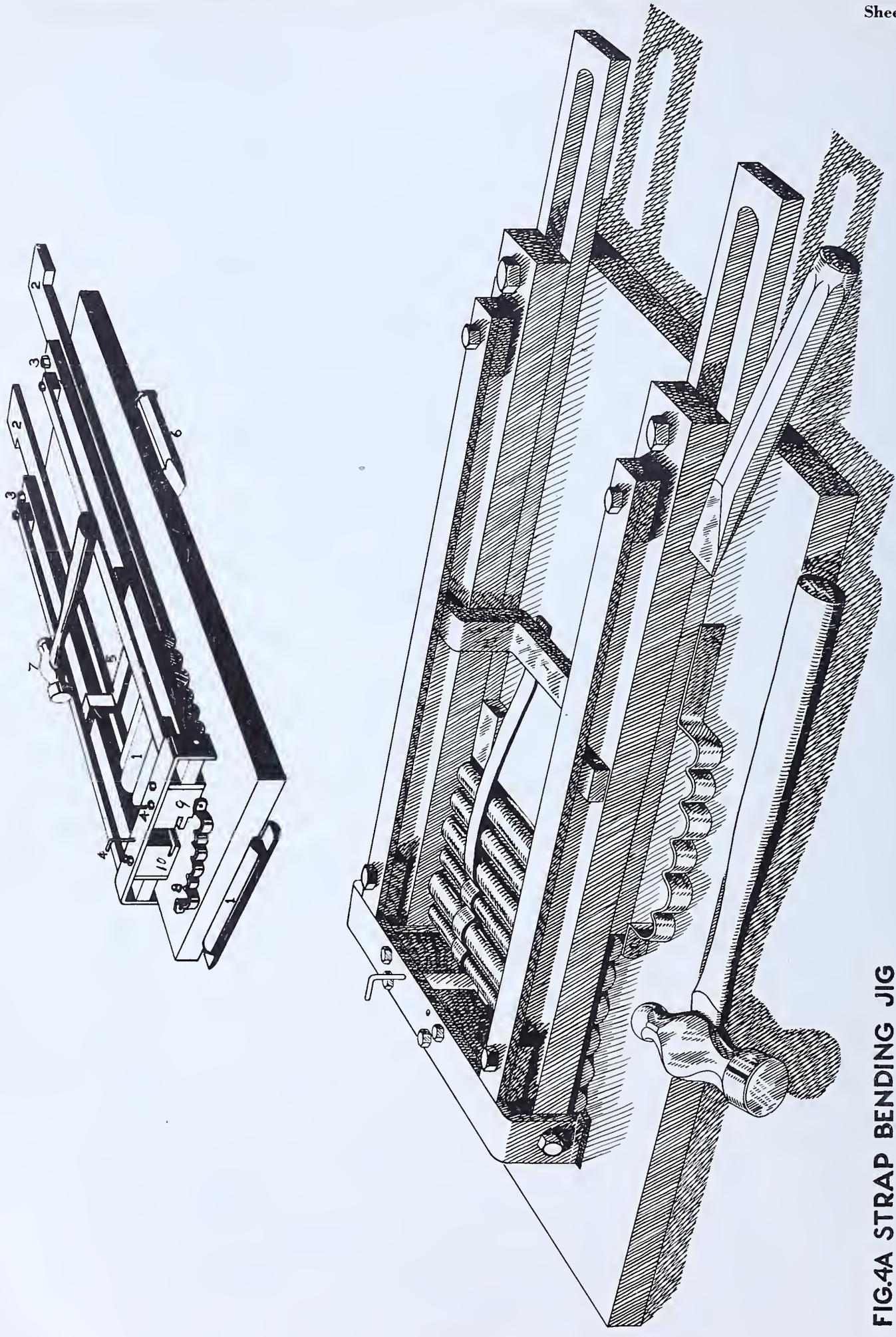
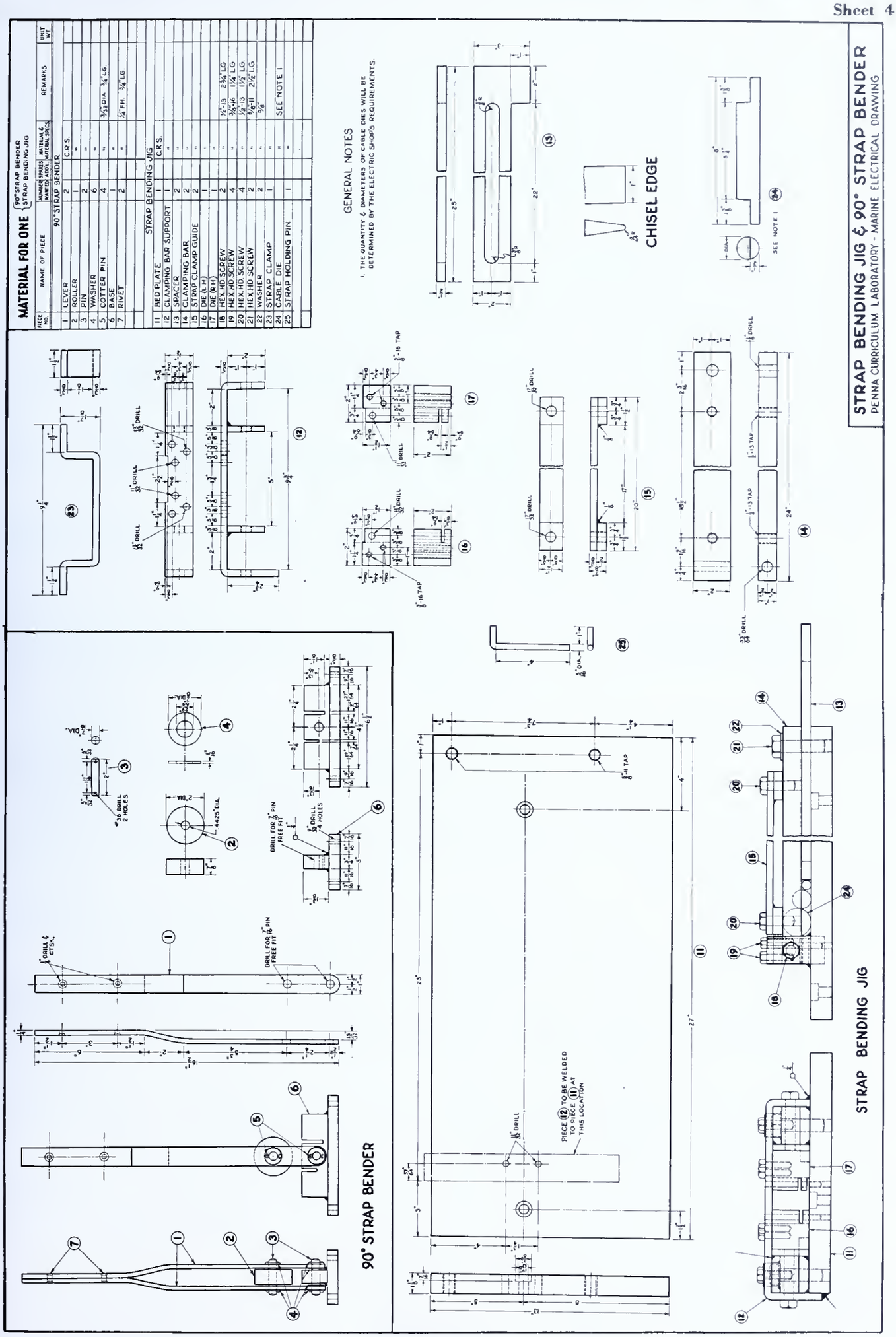


FIG.4A STRAP BENDING JIG


MATERIAL FOR ONE (90° STRAP BENDER / STRAP BENDING JIG)
PIECE NO. | NAME OF PIECE | NAME STOCK MATERIAL | MATERIAL & MATERIAL SPEC. | REMARKS | UNIT WT.
90° STRAP BENDER
1 LEVER 2 C.R.S.
2 ROLLER 1 "
3 PIN 1 "
4 WASHER 2 "
5 COTTER PIN 6 " 3/32 DIA 3/4 LG.
6 BASE 4 " 1/4 FH. 3/4 LG.
7 RIVET 1 "
STRAP BENDING JIG
11 BED PLATE 1 C.R.S.
12 CLAMPING BAR SUPPORT 1 "
13 SPACER 2 "
14 CLAMPING BAR 2 "
15 STRAP CLAMP GUIDE 2 "
16 DIE (L.H.) 1 "
17 DIE (R.H.) 1 "
18 HEX HD SCREW 2 " 1/2-13 2 3/4 LG
19 HEX HD SCREW 4 " 3/8-16 1 1/4 LG
20 HEX HD SCREW 4 " 1/2-13 1 1/2 LG.
21 HEX HD SCREW 2 " 5/8-11 2 1/2 LG.
22 WASHER 2 " 5/8"
23 STRAP CLAMP 1 " SEE NOTE 1
24 CABLE DIE " "
25 STRAP HOLDING PIN 1 "
GENERAL NOTES
1. THE QUANTITY & DIAMETERS OF CABLE DIES WILL BE DETERMINED BY THE ELECTRIC SHOPS REQUIREMENTS.
CHISEL EDGE
SEE NOTE 1
90° STRAP BENDER
STRAP BENDING JIG
PIECE (12) TO BE WELDED TO PIECE (11) AT THIS LOCATION
STRAP BENDING JIG & 90° STRAP BENDER
PENNA CURRICULUM LABORATORY - MARINE ELECTRICAL DRAWING

How to Make Strap Hangers:

13. Insert the ear of strap in the proper slot in bending jig. See Fig. 3A.

    Note: The lower right hand slot is for straps not mounted on pads. The upper right hand slot is for straps mounted on 3/8" pads. The left hand slot is for straps mounted on 5/16" pads.

14. Place strap-holding pin in place through the die and the hole in the ear of the strap.

15. Bend strap down over the cable dies.

16. Slide the wedge block in place to secure the free end of the strap. This will have to be done every once in a while to re-tighten the grip on the strap.

17. Place point of forming chisel over the joint between dies 1 and 2, and strike with hammer to "form" the strap to the contour of Cable 1.

18. Do likewise at Joint Number 2. This will slightly raise the strap at Joint 1, and that joint should be struck lightly with hammer and chisel to re-form. Check tightness of wedge block.

19. Repeat process for each successive joint. After forming each joint, start from Joint 1 and strike in succession each previously formed joint; this insures careful fit.

Bend second ear of strap

20. Place the point of the forming chisel on the strap metal at that spot which will form P_2 (See Fig. 2) and strike it in place. The ability to estimate this location will soon be acquired.

21. Go over all previous joints with hammer and chisel and then remove strap from jig.

22. If strap was not pre-cut to size, measure for the ear at P_2 the same distance as at P_1 and shear to line; punch hole; and round corners.

23. If the material is a pre-cut strap, check to be sure that the ear at P_1 and P_2 are within 1/8" of being equal in length. Discard strap if the ears are not within that tolerance.

24. Fabricate other straps of same type from proper length stock.

25. Remove dies from jig and replace equipment in proper storage.

METHOD O

SINGLE CABLE SUPPORT FOR STEEL DECKS

OR BULKHEADS HAVING INSULATION

(FOR ALTERNATES SEE METHODS BC AND OA)

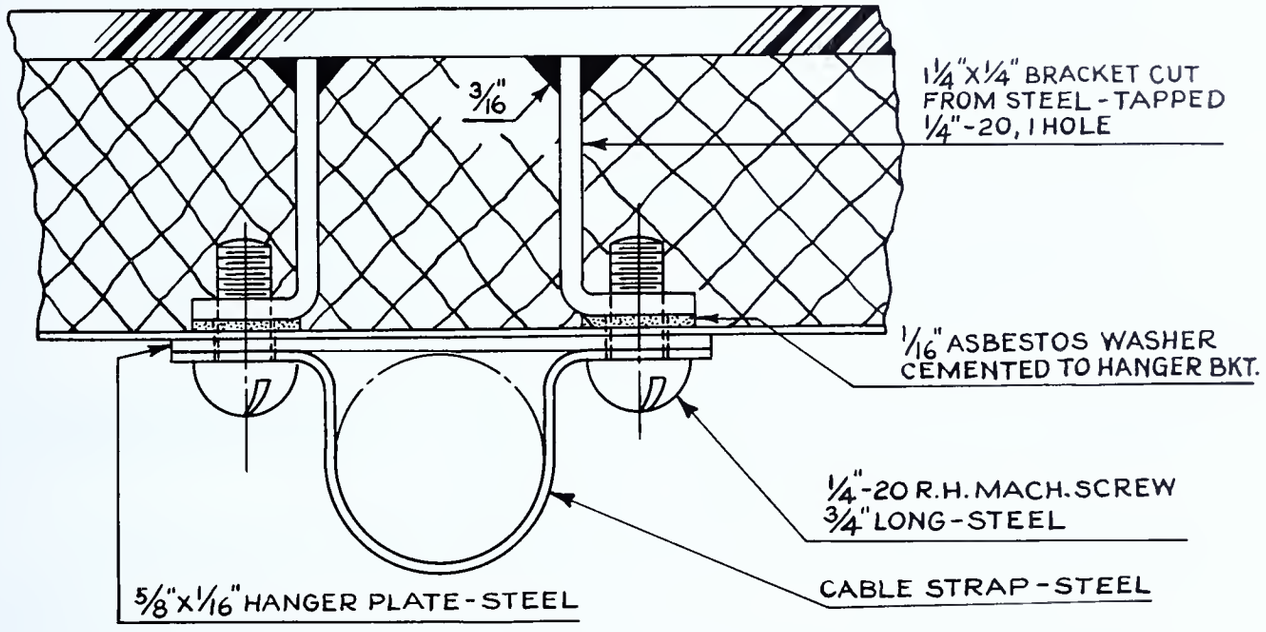

3/16"
1¼"X¼" BRACKET CUT FROM STEEL - TAPPED ¼"-20, 1 HOLE
1/16" ASBESTOS WASHER CEMENTED TO HANGER BKT.
¼"-20 R.H. MACH. SCREW ¾" LONG - STEEL
CABLE STRAP - STEEL
⅝"X1/16" HANGER PLATE - STEEL

FIG. 5

1. Determine the space requirements and location for the cable on the deck or bulkhead.

   Note: The space requirements will be approximately the outside diameter of the cable plus 1-½" to allow for the ears on each side of the strap.

2. Determine thickness of insulation. See Fig. 5.

3. Using a chalk line, strike a bracket line (See Fig. 5) for the full length of the run figured in Step 1.

   Note: Bracket line is approximately 3/4" from the space limits figured in Step 1.

4. Starting at a distance (away from each bulkhead, deck or equipment) to allow for bending radius of cable, center punch bracket location for the first and last strap of run, along the bracket line (Step 3).

5. Determine and mark spacings between cable straps, along the bracket line.

   Note: Strap spacings are not to exceed 16" centerline to centerline.

6. Center punch the deck or bulkhead at intersections determined in Step 5.

7. Select 1-1/4" x 1/4" steel strap material of sufficient length, and manufacture brackets. See Fig. 5.

   Note: Length of material required is approximately equal to thickness of insulation plus 3/8".

   The 3/8" is obtained by adding the thickness of the bracket material (1/4") to thickness of asbestos washer (1/16") and subtracting this total from the ear of the bracket (11/16").

8. Drill and tap the ear of each bracket for 1/4"-20 machine screw. See Fig. 5.

9. Determine the number of cable straps required and manufacture or draw from stock.

   Note: Two-eared straps for single cables of various sizes are usually carried in shop stock.

10. Select 5/8" x 1/16" strap steel material and manufacture hanger plates, using cable straps as templates.

11. Secure bracket to each side of each cable strap, using round head machine screws.

12. Hold one bracket of each bracket and cable strap assembly (Step 11) against deck or bulkhead in locations center punched in Step 6, cable straps to be at right angles to bracket line (Step 3) and brackets parallel to bracket line.

13. Have welder tack-weld brackets to deck or bulkhead.

14. Remove cable straps from brackets and have welder fillet-weld brackets to deck or bulkhead as shown in Fig. 5.

15. Manufacture or draw from stock 1/16" asbestos washers to fit ear of bracket. See Fig. 5.

16. Cement asbestos washer to ear of each bracket, using spar varnish or shellac.

17. After insulation has been installed and during installation of sheathing, have sheet metal worker template and drill holes in sheathing to permit installation of machine screws in brackets.

18. After cable is installed, install hanger plates and cable straps over cable and secure to brackets, using round head machine screws fitted with shakeproof washers.

METHOD OA

SINGLE CABLE SUPPORT FOR STEEL DECKS OR BULKHEADS HAVING INSULATION

(ALTERNATE FOR METHOD O)

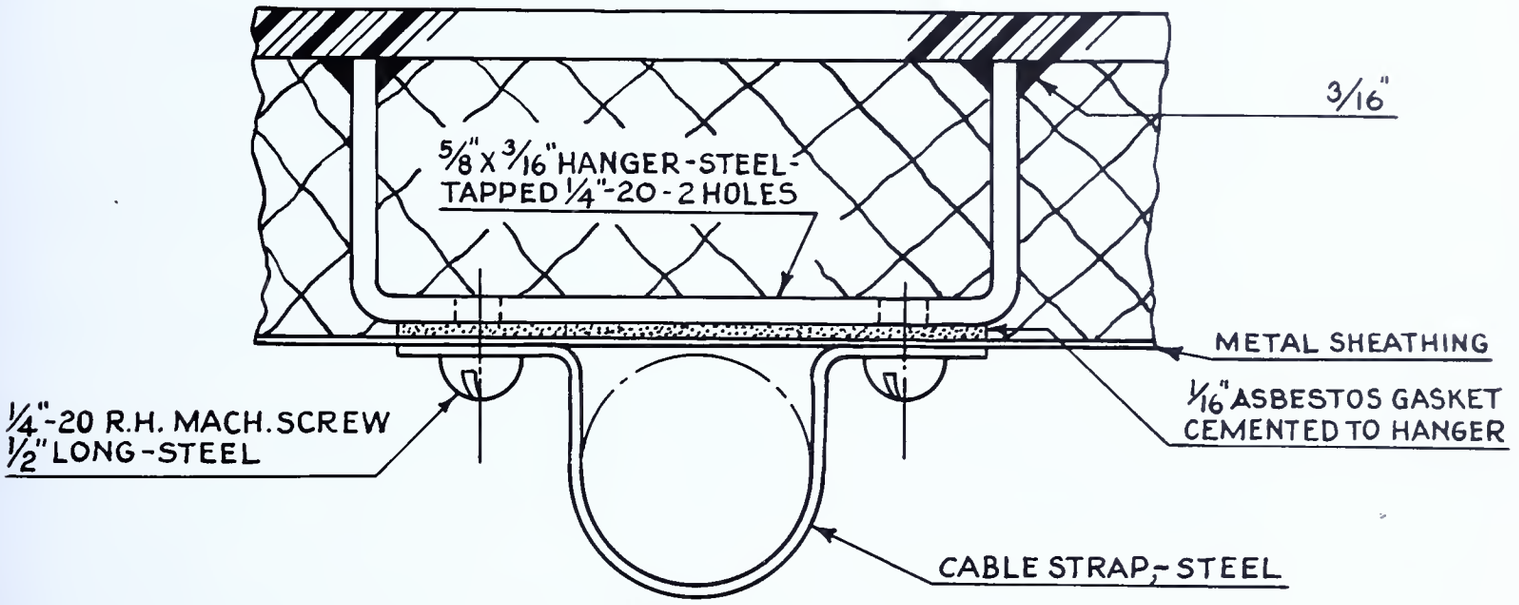


FIG. 6

1. Determine the space requirements and location for the cable on the deck or bulkhead.

   Note: The space requirements will be approximately the outside diameter of the cable plus 2-1/4" to allow for the ear of the cable strap and the hanger material on each side of the cable.

2. Determine thickness of insulation. (See Fig. 6.)

3. Using a chalk line, strike a hanger line (See Fig. 6) for the full length of the run figured in Step 1.

4. Starting at a distance (away from each bulkhead, deck or equipment) to allow for bending radius of cable, center punch hanger location for the first and last strap of run, along the hanger line. (Step 3).

5. Determine and mark spacings between cable straps, along the hanger line.

   Note: Strap spacings are not to exceed 16" centerline to centerline.

6. Center punch the deck or bulkhead at intersections determined in Step 5.

7. Select 5/8" x 3/16" steel strap material of sufficient length and manufacture hangers. See Fig. 6.

8. Determine the number of cable straps required, and manufacture or draw from stock.

   Note: Two-eared straps for single cables of various sizes is usually carried in shop stock.

9. Center a cable strap on each hanger, mark and center punch the center location of the holes in the cable strap on the hanger.

10. Drill and tap each hanger for 1/4"-20 machine screws, in locations center punched in Step 9.

11. Hold one end of hanger on the hanger line at positions center punched in Step 4.

12. Hold hangers (Step 11) at right angles to hanger line and have welder tack-weld free ends to the deck or bulkhead.

13. Where the cable run is straight, stretch a cord between the two hangers (Step 11) and secure to one leg of each hanger on the same side of the cable run.

14. Using the cord as a guide (Step 13), have welder tack-weld the remaining hangers at the locations center punched in Step 6.

15. Have welder fillet-weld both legs of all hangers as shown in Fig. 6.

16. Make 1/16" asbestos washers, using bottom of cable strap as a template. See Fig. 6.

17. Cement asbestos washers to each hanger, using spar varnish or shellac.

18. After insulation has been installed and during installation of sheathing, have sheet metal worker template and drill holes in sheathing to permit installation of machine screws in hangers.

19. After cable is installed, install cable straps over cable and secure to hangers, using round head machine screws fitted with shakeproof washers.

METHOD R

SINGLE CABLE SUPPORT FOR STEEL DECKS OR W. T. BULKHEADS (FOR CABLES UNDER 1" DIAMETER)

(FOR ALTERNATE SEE METHOD AB)

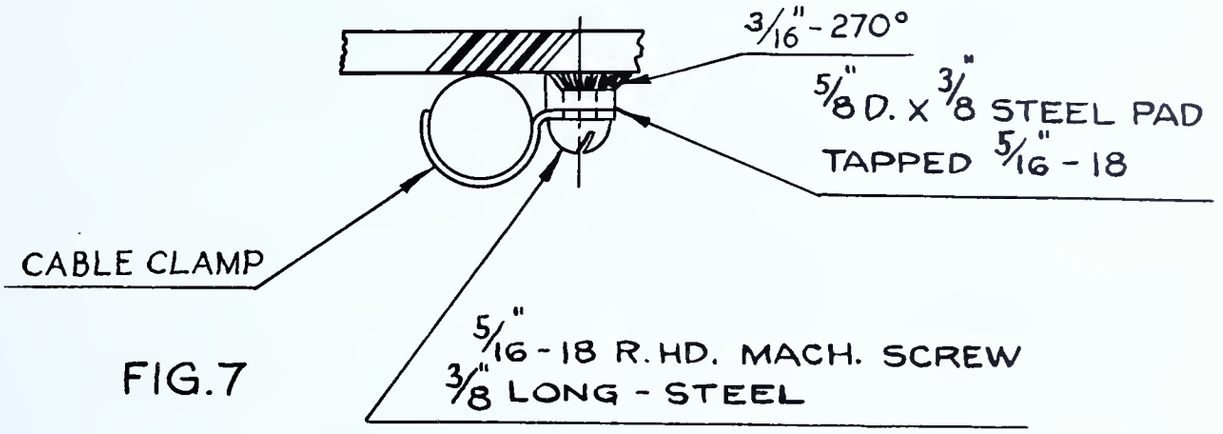


FIG.7

1. Determine the space requirements and location for the cable on the deck or bulkhead.

   Note: The space requirements will be approximately the outside diameter of the cable plus 1/2" to allow for the pad and thickness of the cable strap. See Fig. 7.

2. Using a chalk line, strike a pad line for the full length of the run figured in Step 1.

3. Starting at a distance (away from each bulkhead, deck or equipment) to allow for bending radius of cable, center punch pad locations for the first and last strap of run, along the pad line (Step 2).

4. Determine and mark spacings between cable straps, along the pad line.

   Note: Strap spacings are not to exceed 16" from center line to center line.

5. Center punch the deck or bulkhead at intersections determined in Step 4.

6. Determine number of steel pads required and draw them from stock.

7. Using the pad holder, have welder tack-weld the pads to the deck or bulkhead at each center punch mark along the pad line.

8. Have welder fillet-weld pads for 270° angle on opposite side of cable run. See Fig. 7.

9. Determine the number of cable straps required and manufacture or draw them from stock.

   Note: One-eared straps for single cables of various sizes are usually carried in shop stock.

10. After cable is installed, install cable straps over cable and fasten to the pads, using round head machine screws fitted with shakeproof washers.

METHOD RL-1

SINGLE CABLE SUPPORT FOR ALUMINUM DECKS

METHOD S

SINGLE CABLE SUPPORT FOR STEEL OR ALUMINUM DECKS OR WATERTIGHT BULKHEADS. (FOR CABLES OVER 1" DIA.)

(FOR ALTERNATE SEE METHOD AB)

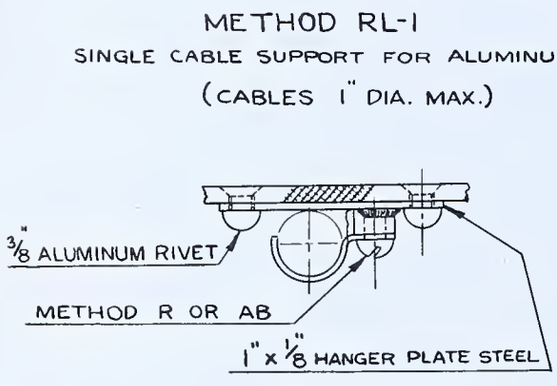

METHOD RL-1
SINGLE CABLE SUPPORT FOR ALUMINUM DECKS
(CABLES 1" DIA. MAX.)
3/8" ALUMINUM RIVET
METHOD R OR AB
1" x 1/8" HANGER PLATE STEEL

FIG-8

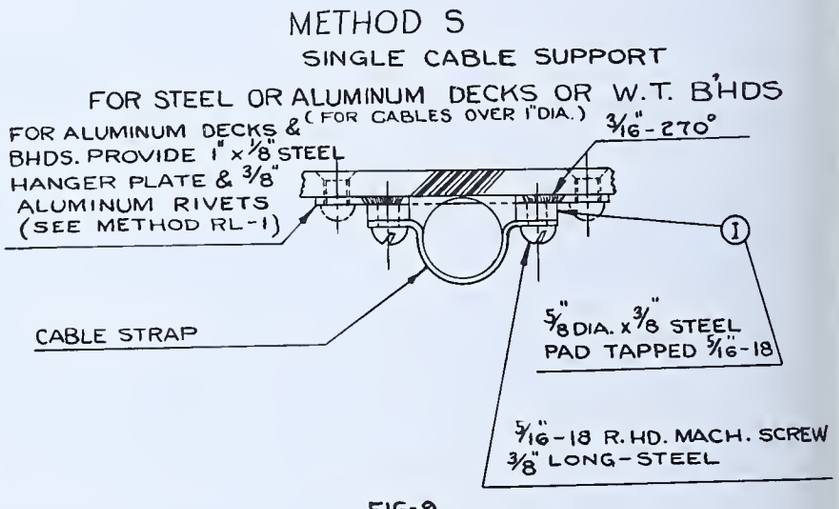

METHOD S
SINGLE CABLE SUPPORT
FOR STEEL OR ALUMINUM DECKS OR W.T. BHDS
(FOR CABLES OVER 1"DIA.)
FOR ALUMINUM DECKS & BHDS. PROVIDE 1" x 1/8" STEEL HANGER PLATE & 3/8" ALUMINUM RIVETS (SEE METHOD RL-1)
3/16"-270°
CABLE STRAP
5/8" DIA. x 3/8" STEEL PAD TAPPED 5/16"-18
5/16"-18 R.HD. MACH. SCREW 3/8" LONG-STEEL

FIG-9

1. Determine the space requirements and location for the cable on the deck or bulkhead.

   Note: The space requirements will be approximately the outside diameter of the cable plus 2-$\frac{1}{2}$" for Method RL-1, 1-5/8" for Method S (steel decks or bulkheads) or 3" for Method S (aluminum decks or bulkheads), to allow for ears of cable strap, thickness of strap on either side of the cable and/or rivet heads.

2. Using a chalk line, strike a rivet or pad line for the full length of the run figured in Step 1.

3. Starting at a distance (away from each bulkhead, deck or equipment) to allow for bending radius of cable, center punch pad or rivet locations for the first and last strap of the run, along the pad or rivet line (Step 2).

4. Determine and mark spacings between cable straps, along the chalk line.

   Note: Strap spacings are not to exceed 16" from center line to center line.

5. Center punch deck or bulkhead at intersections determined in Step 4.

A. FOR METHOD RL-1

6. Have deck drilled for 3/8" flat head aluminum rivets, in locations center punched in Step 5.

7. Determine number of one-eared cable straps required and manufacture or draw them from stock.

   Note: One-eared straps for single cables of various sizes are usually carried in shop stock.

8. Determine length and manufacture hanger plates. See Fig. 8.

9. Determine number of steel pads or studs required and draw them from stock.

10. Have stud end welded or pad tack welded to each hanger plate approximately 1-1/8" from center of rivet hole. See Fig. 8.

11. Secure one end of each hanger plate to deck at drilled holes (Step 6), using suitable round head machine screws and nuts.

12. Hold each hanger plate against the deck at right angles to the chalk line (Step 2), mark and center punch the deck at the center locations of the hole in the free end of each hanger plate.

13. Remove round head machine screws, nuts and hanger plates from the deck.

14. Have deck drilled for 3/8" flat head aluminum rivets, in locations center punched in Step 12.

15. Have hanger plates riveted to the deck as shown in Fig. 8.

    Note: All pads are to be on the same side of the cable.

16. Have hanger plates riveted to the deck or bulkhead as shown in Fig. 9.

17. After cable is installed, install cable straps over cable and fasten to the pads, using round head machine screws fitted with shakeproof washers.

B. FOR METHOD S - (STEEL DECKS AND BULKHEADS)

6. Using the pad holder, have welder tack weld the pads to the deck or bulkhead at each center punch mark (Step 5).

7. Determine number of two-eared cable straps required and manufacture or draw from stock.

   Note: Two-eared straps for single cables of various sizes are usually carried in shop stock.

8. Secure a steel pad to one side of each cable strap, using a round head machine screw.

9. Secure cable straps to pads welded to the deck or bulkhead (Step 6), using round head machine screws.

10. Hold each cable strap in position against the deck or bulkhead with a wooden stick or hammer handle. Cable strap to be at right angles to the pad lines.

11. Have welder tack weld free pads to the deck or bulkhead.

12. Remove cable straps from pads and have welder fillet weld pad for 270° angle on opposite side of cable. See Fig. 9.

13. After cable is installed, install cable straps over cable and fasten to the pads, using round head machine screws fitted with shakeproof washers.

14. Tighten machine screws, using a screw driver.

C. FOR METHOD S (ALUMINUM DECKS OR BULKHEADS)

6. Have deck drilled for 3/8" flat head aluminum rivets, in locations center punched in Step 5.

7. Determine number of two-eared cable straps required and manufacture or draw from stock.

   Note: Two-eared straps for single cables of various sizes are usually carried in shop stock.

8. Determine length and manufacture hanger plates. (See Fig. 9)

9. Determine number of steel pads or studs required and draw from stock.

10. Secure a steel pad to each side of each cable strap, using round head machine screws.

11. Center cable strap on each hanger plate and have welder tack-weld steel pads to hanger plate.

12. Remove cable strap from hanger plate and have welder fillet weld pads for 270° angle as shown in Fig. 9.

13. Secure one end of each hanger plate to the deck or bulkhead at drilled holes (Step 6), using suitable round head machine screws and nuts.

14. Hold each hanger plate against the deck or bulkhead at right angles to the chalk line (Step 2). Mark and center punch the deck at the center locations of the hole in the free end of each hanger plate.

15. Have deck or bulkhead drilled for 3/8" flat head aluminum rivets, in locations center punched in Step 14.

16. Have hanger plates riveted to the deck or bulkhead as shown in Fig. 9.

17. After cable is installed, install cable straps over cable and fasten to the pads, using round head machine screws fitted with shakeproof washers.

18. Tighten machine screws, using a screw driver.

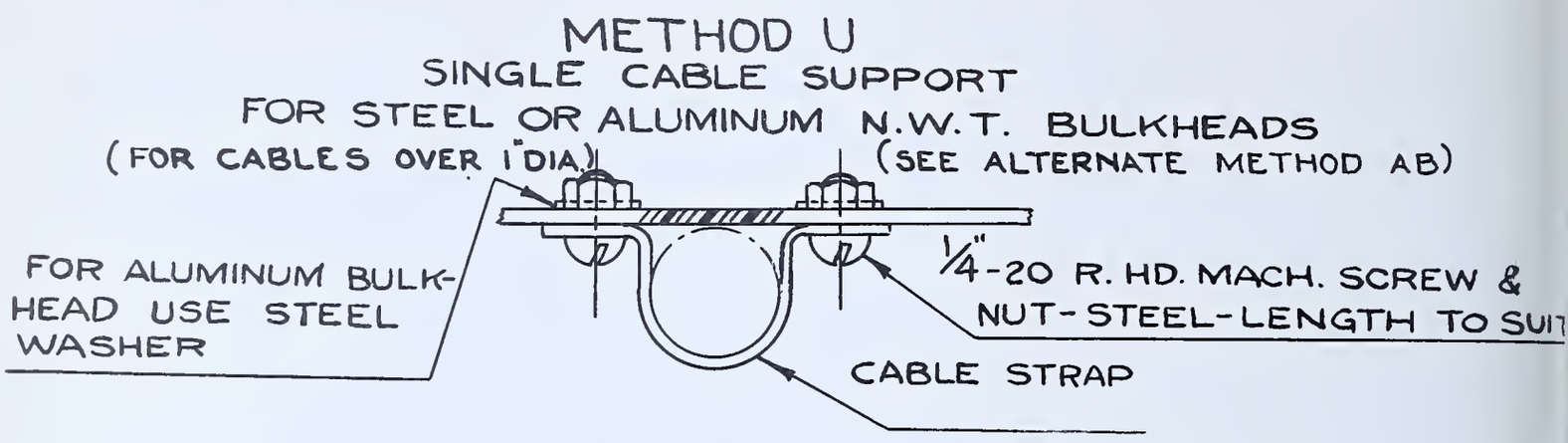

METHOD U
SINGLE CABLE SUPPORT
FOR STEEL OR ALUMINUM N.W.T. BULKHEADS
(FOR CABLES OVER 1" DIA.)
(SEE ALTERNATE METHOD AB)
FOR ALUMINUM BULK-HEAD USE STEEL WASHER
1/4"-20 R. HD. MACH. SCREW & NUT-STEEL-LENGTH TO SUIT
CABLE STRAP

FIG.-10

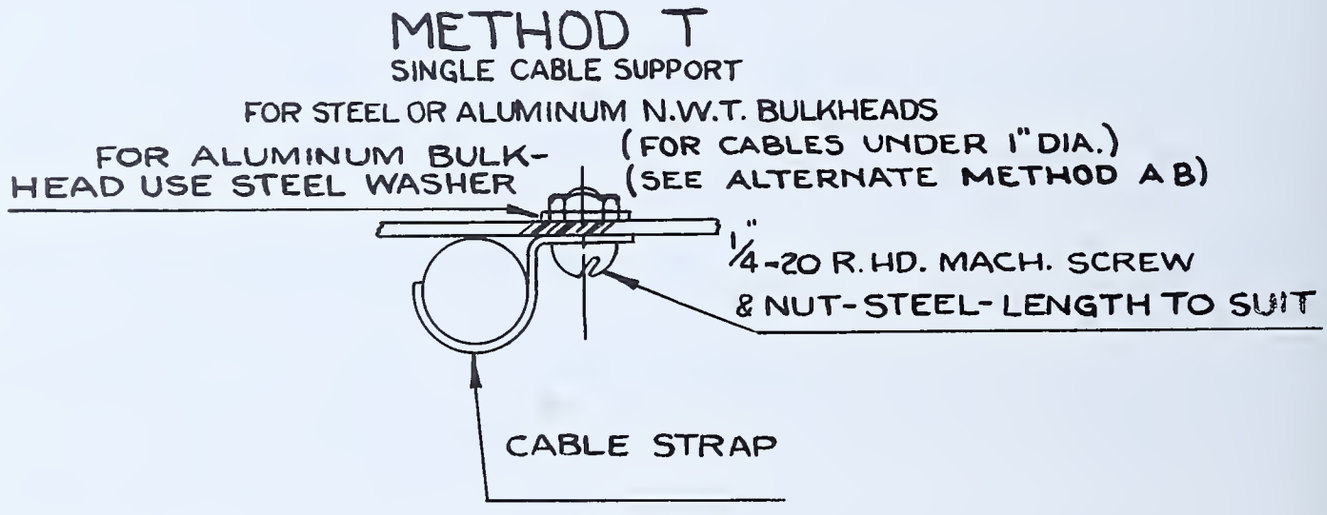

METHOD T
SINGLE CABLE SUPPORT
FOR STEEL OR ALUMINUM N.W.T. BULKHEADS
(FOR CABLES UNDER 1" DIA.)
(SEE ALTERNATE METHOD AB)
FOR ALUMINUM BULK-HEAD USE STEEL WASHER
1/4"-20 R. HD. MACH. SCREW & NUT-STEEL-LENGTH TO SUIT
CABLE STRAP

FIG.-11

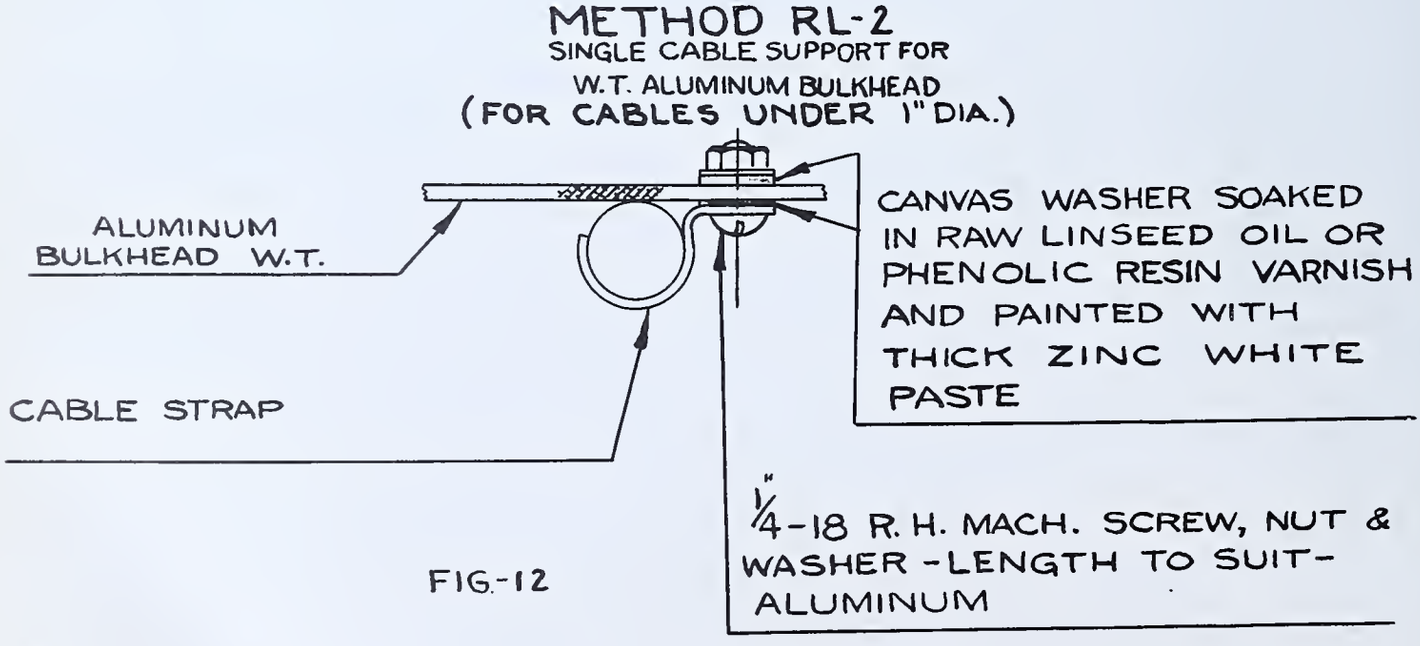

METHOD RL-2
SINGLE CABLE SUPPORT FOR
W.T. ALUMINUM BULKHEAD
(FOR CABLES UNDER 1" DIA.)
ALUMINUM BULKHEAD W.T.
CANVAS WASHER SOAKED IN RAW LINSEED OIL OR PHENOLIC RESIN VARNISH AND PAINTED WITH THICK ZINC WHITE PASTE
CABLE STRAP
1/4"-18 R. H. MACH. SCREW, NUT & WASHER -LENGTH TO SUIT- ALUMINUM

FIG.-12

Procedure:

1. Determine the space requirements and location for the cable on the bulkhead.

   Note: The space requirements will be approximately the outside diameter of the cable plus 3/4" for one-eared straps and 1-$\frac{1}{2}$" for two-eared straps, to allow for ears of cable strap and thickness of strap on either side of cable. (See Figs. 10, 11 and 12.)

2. Using a chalk line, strike a line for securing screws for the cable straps for the full length of the run figured in Step 1.

3. Starting at a distance (away from each bulkhead, deck or equipment) to allow for bending radius of cable, center punch hole locations for first and last strap of the run, along the chalk line (Step 2).

4. Determine and mark spacings between cable straps along the chalk line.

   Note: Strap spacings are not to exceed 16" center line to center line.

5. Center punch bulkhead at intersections determined in Step 4.

6. Have bulkhead drilled for 1/4" machine screws, in locations center punched in Step 5.

7. Determine number of cable straps required and manufacture or draw from stock.

   Note: One-eared and two-eared straps for single cables of various sizes are usually carried in shop stock.

8. Determine number and length of 1/4"-20 round head machine screws, nuts and flat steel washers required and draw from stock.

A. FOR METHOD RL-2 ONLY

9. Draw from stock or make canvas washers to fit flat washers (See Fig. 12). Soak washers in raw linseed oil or phenolic resin varnish and paint with thick zinc white paste.

B. FOR METHODS T and RL-2 ONLY

9. After cable is installed, install cable straps over the cable and secure to bulkhead, using round head machine screws, nuts and washers as shown in Figs. 11 and 12.

10. Tighten machine screws and nuts.

C. FOR METHOD U ONLY

9. Secure one end of the cable straps to the bulkhead, using suitable round head machine screws and nuts. See Fig. 10.

10. Hold each cable strap against the bulkhead at right angles to the chalk line (Step 2), mark and center punch the bulkhead at the center locations of the hole in the free end of each cable strap.

11. Remove round head machine screws, nuts and cable strap from the bulkhead.

12. Have bulkhead drilled for 1/4" machine screws in locations center punched in Step 10.

13. After cable is installed, install cable straps over the cable and secure to the bulkhead, using round head machine screws, nuts and washers as shown in Fig. 10.

14. Tighten machine screws and nuts.

METHOD A

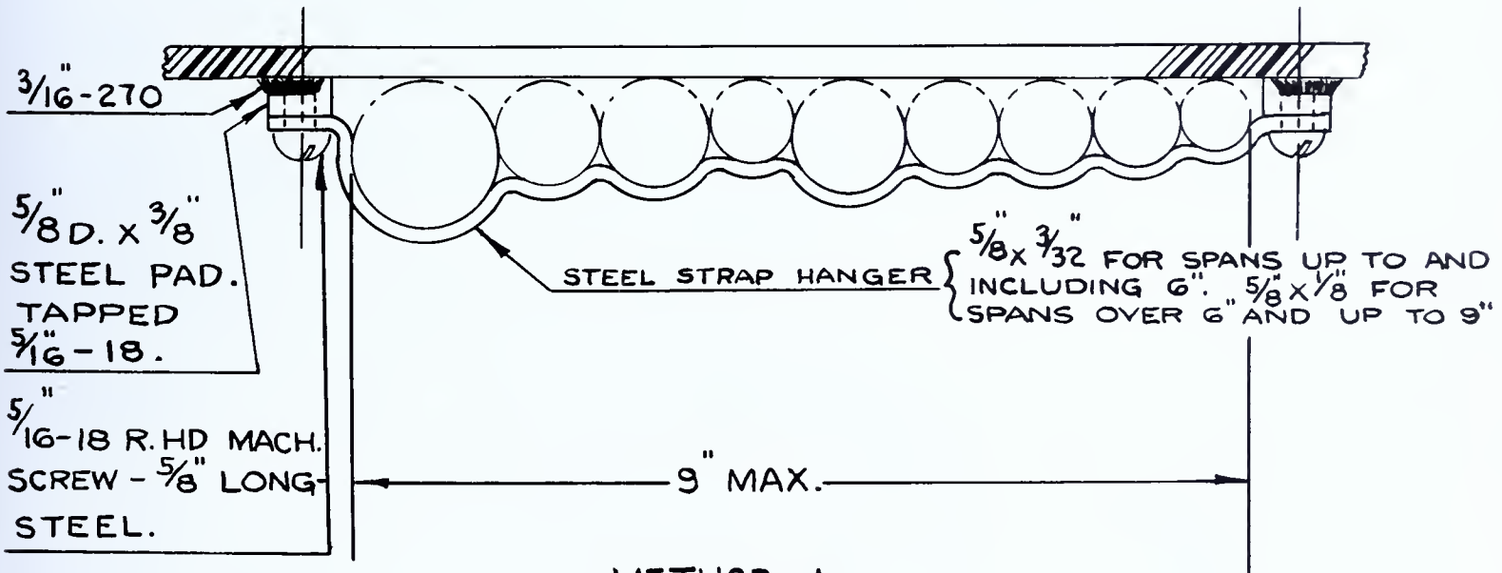
METHOD OF SUPPORTING A SINGLE ROW OF CABLES ON STEEL DECKS AND WATERTIGHT BULKHEADS

METHOD A1

METHOD OF SUPPORTING CABLES TO KEEP THEM AWAY FROM WET DECKS AND BULKHEADS IN MACHINERY SPACES, FIRE ROOMS, MESS COMPARTMENTS, WASH ROOMS, WATER CLOSETS AND IN OTHER SPACES WHERE EXCESSIVE MOISTURE AND DRIP IS PRESENT

Note: Method A is not to be used in compartments where excessive moisture and drip is present. For supporting cables in compartments of this nature, see Methods A1 and A2.

For an alternate to Method A, see Method AB.


3/16"-270
5/8" D. X 3/8" STEEL PAD. TAPPED 5/16"-18.
5/16"-18 R.HD MACH. SCREW - 5/8" LONG-STEEL.
STEEL STRAP HANGER
5/8" X 3/32" FOR SPANS UP TO AND INCLUDING 6". 5/8" X 1/8" FOR SPANS OVER 6" AND UP TO 9"
9" MAX.

METHOD - A

HANGER SPACING NOT TO EXCEED 16" ℄ TO ℄ ON VERTICAL RUNS. HANGER SPACING NOT TO EXCEED 16" ℄ TO ℄ ON HORIZONTAL RUNS

FIG. 13

1. Determine the space requirements and select location for the cable run to be installed on the deck or bulkhead.

2. Using a chalk line, strike pad lines for the full length of the run figured in Step 1.

   Note: The space between pad lines is approximately 1" more than the space requirements for the cable, to allow for the pad and bend of the strap hanger on either side of the cable run.

3. Starting at a distance (away from each bulkhead, deck or equipment) to allow for bending radius of cables, center punch pad locations for first and last strap of run, along one pad line.

4. Determine and mark spacings between strap hangers, along the pad line selected in Step 3.

5. Center punch deck or bulkhead at intersections determined in Step 4.

6. Determine number of steel pads required and draw from stock.

7. Using the pad holder, have welder tack weld the pads to the deck or bulkhead at each center punch mark along the pad line.

8. Select material and make strap hangers to suit cable run.

METHOD - A1

ALTERNATE FOR METHOD A

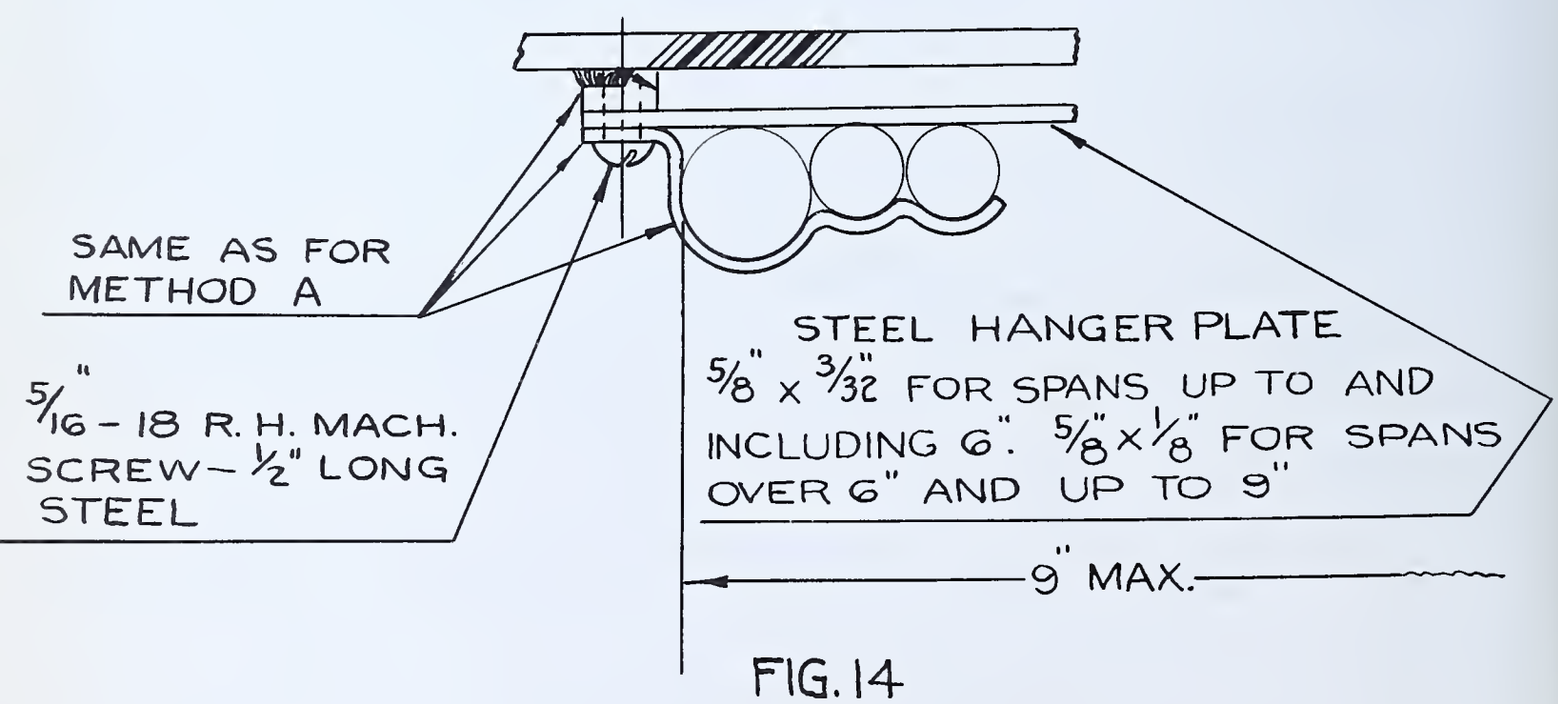

SAME AS FOR METHOD A
5/16" - 18 R. H. MACH. SCREW - 1/2" LONG STEEL
STEEL HANGER PLATE 5/8" x 3/32" FOR SPANS UP TO AND INCLUDING 6". 5/8" x 1/8" FOR SPANS OVER 6" AND UP TO 9"
9" MAX.

FIG. 14

9. For Method A1 only, select material and make strap hanger plates, using strap hangers as templates. See Fig. 14.

10. Secure a steel pad to one side of each strap hanger, using a round head machine screw.

11. Secure strap hangers to pads welded to deck or bulkhead (Step 7), using round head machine screws.

12. Hold each strap hanger in position against the deck or bulkhead with a wooden stick or hammer handle, strap hanger to be at right angles to the pad line.

13. Have welder tack weld free pads to deck or bulkhead.

14. Remove strap hangers from pads and have welder fillet weld pad for 270° angle on opposite side of cable run. See Figs. 13 and 14.

15. After cables are installed, install strap hangers (and hanger plates for Method A1) over cable and fasten to the pads, using round head machine screws fitted with shakeproof washers.

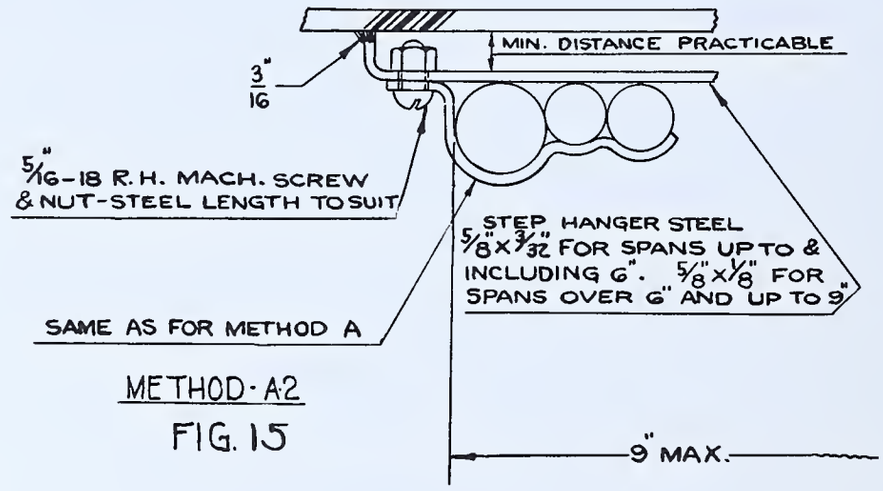
METHOD A2

METHOD OF SUPPORTING CABLES TO KEEP THEM AWAY FROM WET DECKS AND BULKHEADS IN MACHINERY SPACES, FIRE ROOMS, MESS COMPARTMENTS, WASH ROOMS, WATER CLOSETS AND IN SUCH OTHER SPACES WHERE EXCESSIVE MOISTURE AND DRIP IS PRESENT

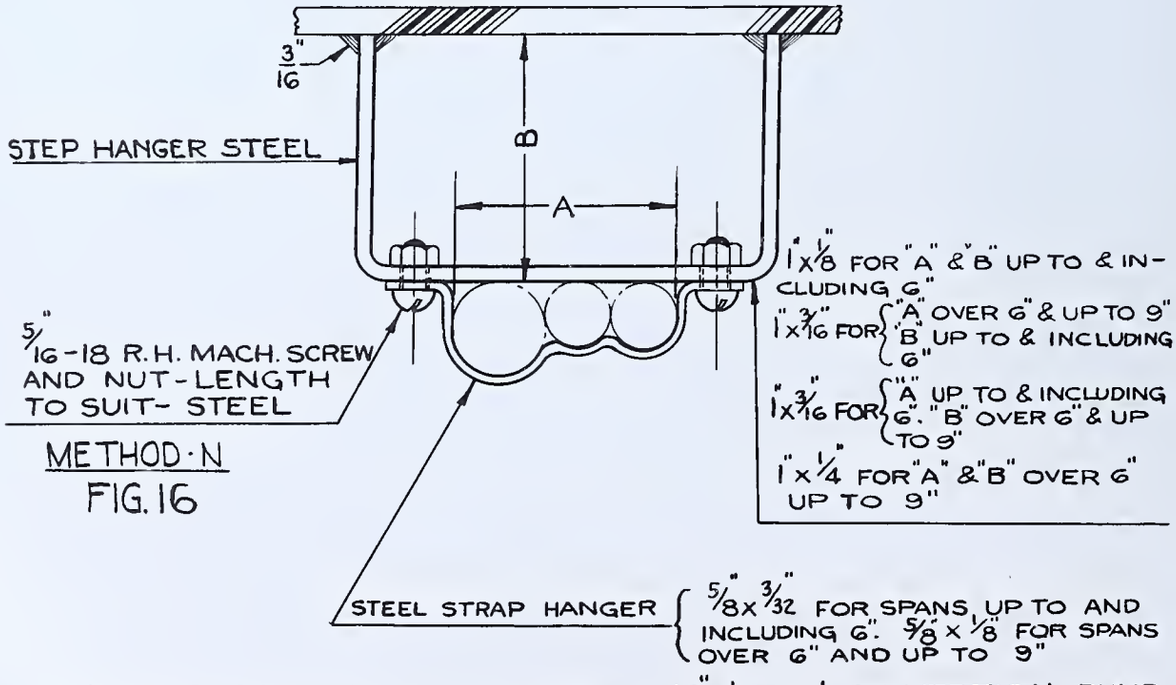
(Alternate for Methods A and A1

METHOD N

METHOD OF SUPPORTING CABLES AWAY FROM STEEL DECK OR BULKHEAD TO AVOID AN OBSTRUCTION, OR PRESERVE ALIGNMENT OF CABLE RUNS


MIN. DISTANCE PRACTICABLE
3/16"
5/16"-18 R.H. MACH. SCREW & NUT-STEEL LENGTH TO SUIT
STEP HANGER STEEL 5/8"x3/32" FOR SPANS UP TO & INCLUDING 6". 5/8"x1/8" FOR SPANS OVER 6" AND UP TO 9"
SAME AS FOR METHOD A
9" MAX.

METHOD-A2
FIG. 15


3/16"
STEP HANGER STEEL
B
A
5/16"-18 R.H. MACH. SCREW AND NUT-LENGTH TO SUIT- STEEL
1"x1/8" FOR "A" & "B" UP TO & INCLUDING 6"
1"x3/16" FOR "A" OVER 6" & UP TO 9" "B" UP TO & INCLUDING 6"
1"x3/16" FOR "A" UP TO & INCLUDING 6". "B" OVER 6" & UP TO 9"
1"x1/4" FOR "A" & "B" OVER 6" UP TO 9"
STEEL STRAP HANGER 5/8"x3/32" FOR SPANS UP TO AND INCLUDING 6". 5/8"x1/8" FOR SPANS OVER 6" AND UP TO 9"

METHOD-N
FIG. 16

HANGER SPACING NOT TO EXCEED 16" ℄ TO ℄ ON VERTICAL RUNS
HANGER SPACING NOT TO EXCEED 16" ℄ TO ℄ ON HORIZONTAL RUNS

1. Determine the space requirements and location for the cable run to be installed on the deck or bulkhead.

2. Determine clearance distance required between wireway and bulkhead. See Fig. 15 and Fig. 16.

3. Using a chalk line, strike lines for the step hanger (Fig. 15) or angle plate (Fig. 16) for the full length of the run figured in Step 1.

   Note: The space between the lines is approximately $2\frac{1}{4}$" more than the space requirements for the cable, to allow for the securing screw and nut, the bend of the step hanger or angle plate and strap hanger on either side of the cable run.

4. Starting at a distance (away from each bulkhead, deck or equipment) to allow for bending radius of cables, center punch the center location of the first and last step hanger or angle plate along one line (Step 3).

5. Determine and mark spacings between step hangers or angle plate along the line selected in Step 4.

6. Center punch deck or bulkhead at intersections determined in Step 5.

7. Select material and make step hangers or angle plates to suit the cable run.

8. Determine length of step hanger or angle plate.

   Note: Length of step hanger or angle plate material will be the over-all length of strap hanger (Step 7) plus 1/2" plus twice the distance obtained in Step 2. The 1/2" is to allow 1/4" clearance between each end of step hanger or angle plate and the nut on the securing bolt.

9. Select material and make step hangers or angle plates.

10. Drill holes in step hangers or angle plates, using strap hangers as templates.

11. Hold the step hangers or angle plates over the lines on the deck or bulkhead (Step 3) and set one end of each step hanger or angle plate on the line at positions selected in Step 4, (one-half the width of the material on each side of the center punch mark (Step 6). Have welder tack weld one side of step hangers or angle plate to the deck or bulkhead.

12. Hold step hangers on angle plates (Step 11) at right angles to chalk line and have welder tack weld free ends to the deck or bulkhead.

13. Where the wireway is straight, stretch a cord between the two step hangers or angle plates (Step 11) and secure to one leg of each step hanger or angle plate on the same side of the cable run.

14. Using the cord as a guide, (Step 13), have the welder tack-weld the remaining step hangers or angle plates at the locations center punched in Step 6.

15. Have welder fillet weld both legs of all step hangers as shown in Fig. 15 or angle plates as shown in Fig. 16.

16. After cables are installed, install strap hangers and secure to the step hangers or angle plates as shown in Fig. 15 or Fig. 16.

METHOD B

METHOD OF SUPPORTING A SINGLE ROW OF CABLES

ON STEEL OR ALUMINUM N. W. T. BULKHEADS

(For Alternate See Method AB)

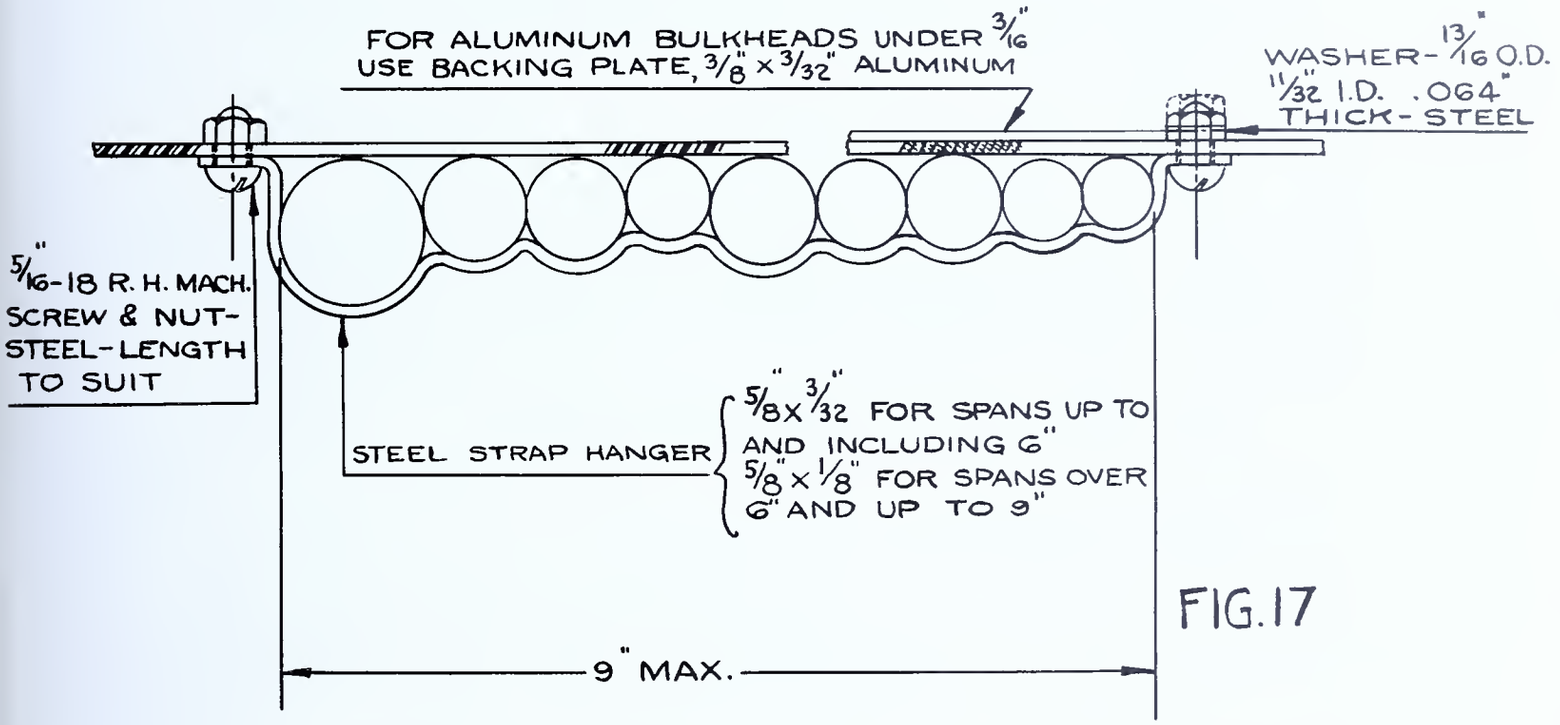

FOR ALUMINUM BULKHEADS UNDER 3/16" USE BACKING PLATE, 3/8" x 3/32" ALUMINUM
WASHER - 13/16" O.D. 11/32" I.D. .064" THICK - STEEL
5/16"-18 R. H. MACH. SCREW & NUT - STEEL - LENGTH TO SUIT
STEEL STRAP HANGER
5/8" X 3/32" FOR SPANS UP TO AND INCLUDING 6"
5/8" X 1/8" FOR SPANS OVER 6" AND UP TO 9"
9" MAX.

FIG. 17

HANGER SPACING NOT TO EXCEED 16" ℄ TO ℄ ON VERTICAL RUNS.
HANGER SPACING NOT TO EXCEED 16" ℄ TO ℄ ON HORIZONTAL RUNS.

1. Determine the space requirements and select location for the cable run to be installed.

2. Using a chalk line, strike lines for the strap hanger (Fig. 17) for the full length of the run figured in Step 1.

   Note: The space between the lines is approximately 1" more than the space requirements for the cable, to allow for the head of the securing screw and the bend of the strap hanger on either side of the cable run.

3. Starting at a distance (away from each bulkhead, deck, or equipment) to allow for bending radius of cables, center punch center location of the first and last step hanger along one line (Step 2).

4. Determine and mark spacings between strap hangers, along the line selected in Step 3.

5. Center punch bulkhead at intersections determined in Step 4.

6. Have bulkhead drilled for 5/16" machine screws, in locations center punched in Step 5.

7. Select material and make strap hangers to suit cable run.

8. For aluminum bulkheads under 3/16" only - Select material and make backing plates, using strap hangers as templates See Fig. 17.

9. Secure one end of strap hangers to the bulkhead, using suitable round head machine screws and nuts. See Fig. 17.

10. Hold each strap hanger against the bulkhead at right angles to the chalk lines (Step 2) and mark and center punch the bulkhead at the center location of the hole in the free end of each strap hanger.

11. Have bulkhead drilled for 5/16" machine screws, in location center punched in Step 10.

12. Remove round head machine screws, nuts and strap hangers from the bulkhead.

13. After cables are installed, install cable straps (and backing plates for aluminum bulkheads under 3/16"), using round head machine screws, nuts and washers as shown in Fig. 17.

METHOD C

METHOD OF SUPPORTING A SINGLE ROW OF CABLES ON STEEL DECKS AND BULKHEADS HAVING INSULATION

(For Alternate See Method BC)

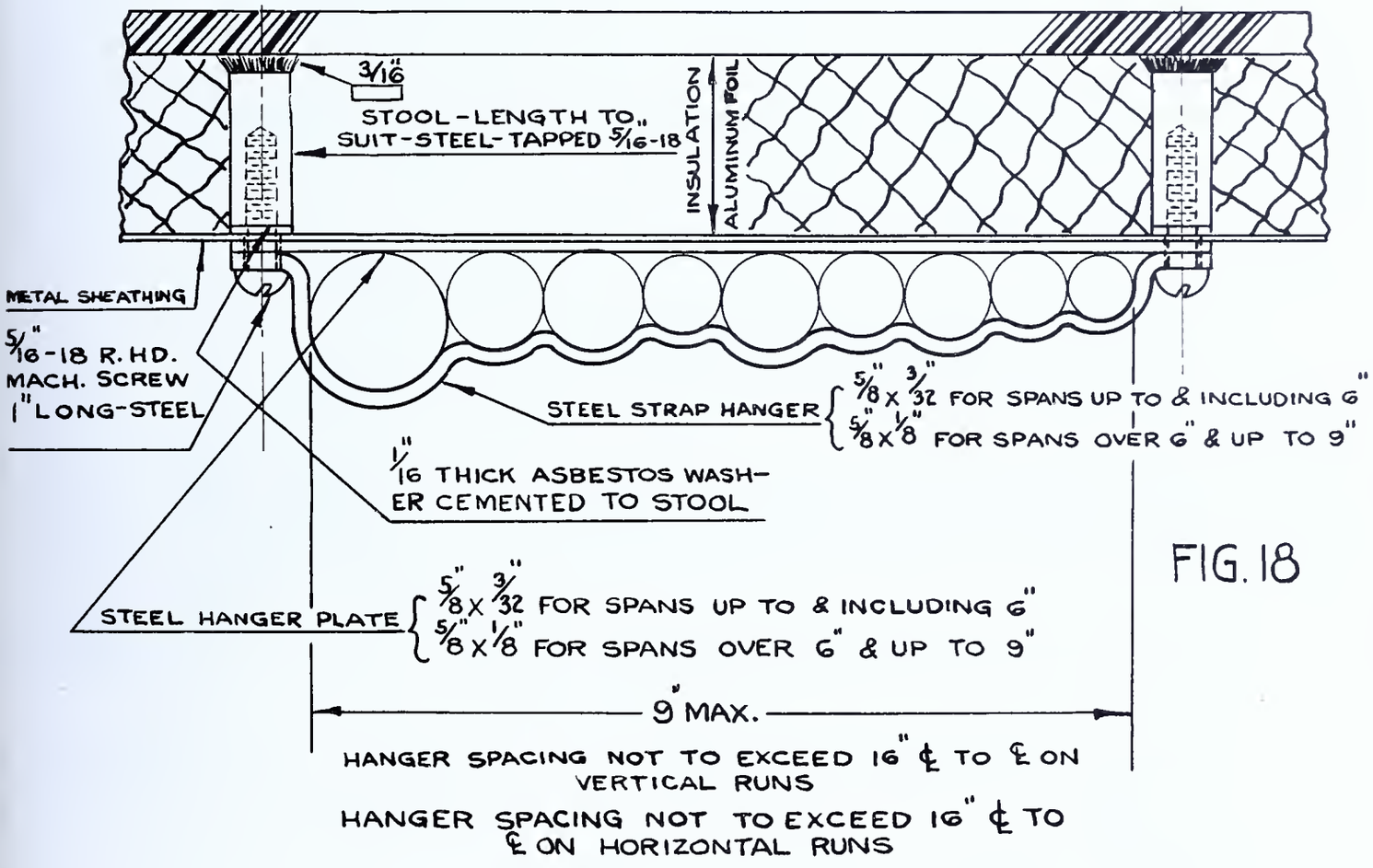

3/16"
STOOL - LENGTH TO SUIT - STEEL - TAPPED 5/16-18
INSULATION
ALUMINUM FOIL
METAL SHEATHING
5/16-18 R.HD. MACH. SCREW 1" LONG-STEEL
STEEL STRAP HANGER
5/8 X 3/32 FOR SPANS UP TO & INCLUDING 6"
5/8 X 1/8 FOR SPANS OVER 6" & UP TO 9"
1/16 THICK ASBESTOS WASHER CEMENTED TO STOOL
STEEL HANGER PLATE
5/8 X 3/32 FOR SPANS UP TO & INCLUDING 6"
5/8 X 1/8 FOR SPANS OVER 6" & UP TO 9"
9" MAX.
HANGER SPACING NOT TO EXCEED 16" ℄ TO ℄ ON VERTICAL RUNS
HANGER SPACING NOT TO EXCEED 16" ℄ TO ℄ ON HORIZONTAL RUNS

FIG. 18

1. Determine the space requirements and location for the cable run to be installed on the deck or bulkhead.

2. Determine thickness of insulation. See Fig. 18.

3. Using a chalk line, strike stool lines (Fig. 18) for the full length of the run figured in Step 1.

   Note: The space between the lines is approximately 1" more than the space requirements for the cable, to allow for the head of the securing screw and the bend of the strap hanger on either side of the cable run.

4. Starting at a distance (away from each deck, bulkhead or equipment) to allow for bending radii of cables, center punch stool locations for first and last strap of run along one stool line.

5. Determine and mark spacings between strap hangers along the stool line selected in Step 4.

6. Center punch deck or bulkhead at intersections determined in Step 5.

7. Determine length of stools required (thickness of insulation, Step 2, less 1/16").

   Note: The 1/16" is to permit insertion of washer. See Fig. 18.

8. Draw from stock stools in sufficient quantity and of sufficient length to suit dimension obtained in Step 7. A detail of the stool is shown in Fig. 19.

9. Mark off dimension obtained in Step 7 on each stool, starting from the tapped end of each stool.

10. If required, cut off excess ends of stools, using a hack saw and vise.

11. Have welder tack weld stools to the deck or bulkhead at each center punch mark along stool line (Step 6).

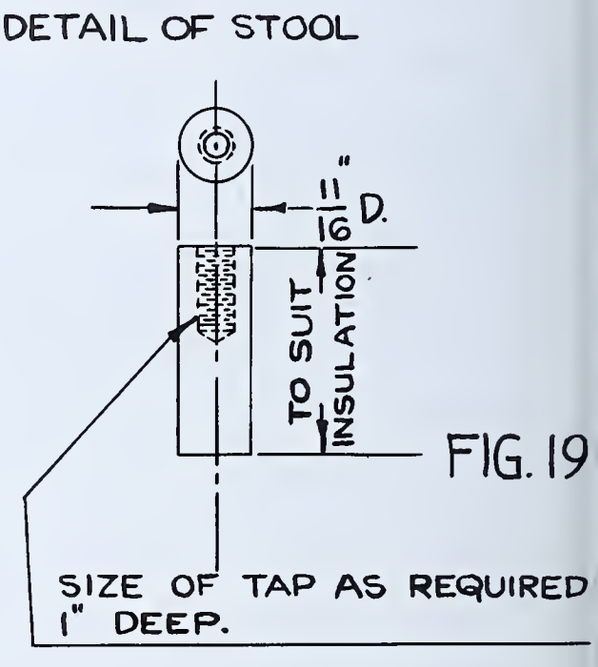


FIG. 19

12. Select material and make strap hangers to suit cable run.

13. Select material and make hanger plates, using strap hangers as templates. See Fig. 18.

14. Secure a stool to one side of each hanger plate, using suitable round head machine screws.

15. Secure hanger plates to stools welded to deck or bulkhead (Step 11), using round head machine screws.

16. Hold each hanger plate in position against the deck or bulkhead with a wooden stick or hammer handle, hanger plate to be at right angles to the stool line.

17. Have welder tack weld free stools to the deck or bulkhead.

18. Remove hanger plates from stools and have welder fillet weld all stools all around.

19. Draw from stock or make 1/16" thick asbestos washers to fit on the end of each stool. See Fig. 18.

20. Cement washer (Step 19) on each stool, using spar varnish or shellac.

21. After insulation has been installed and during installation of sheathing, have sheet metal worker template and drill holes in sheathing to permit installation of machine screws in stools.

22. After cables are installed, install hanger plates and strap hangers over cables and fasten to the stools (see Fig. 18), using suitable round head machine screws fitted with shake-proof washers.

METHOD AB

ALTERNATE METHOD OF SUPPORTING CABLE HANGERS

FOR METHODS A, B, R, S, T, U AND X

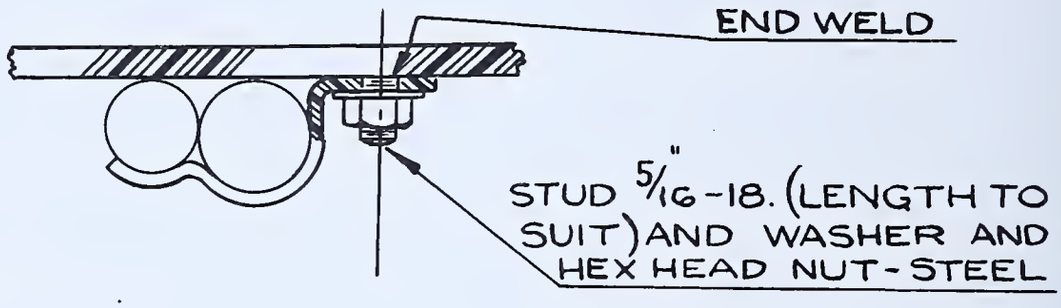


FIG. 20

1. Determine the space requirements and select location for the cable run to be installed on the deck or bulkhead.

2. Using a chalk line, strike stud lines (Fig. 20) for the full length of the run figured in Step 1.

   Notes: (a) For two-eared strap hangers, the space between the stud lines is approximately 1" more than the space requirements for the cable, to allow for the stud, nut and bend of the strap hanger on either side of the cable run.

   (b) For one-eared straps, the stud line is approximately $\frac{1}{2}$" away from the space requirements for the cable.

3. Starting at a distance (away from each bulkhead, deck or equipment) to allow for the bending radii of cables, center punch stud locations for first and last strap of run, along one stud line.

4. Determine and mark spacings between strap hangers, along the stud line selected in Step 3.

5. Center punch deck or bulkhead at intersections determined in Step 4.

6. Determine number and length of 5/16"-18 studs and nuts required and draw from stock.

7. Have welder end weld studs to the deck or bulkhead at each center punch mark along the stud line (Step 5).

B. FOR CABLE RUNS REQUIRING TWO-EARED STRAP HANGERS

8. Select material and make strap hangers to suit cable run.

9. Install strap hangers on studs welded to deck or bulkhead (Step 7) and secure with hexagon nut.

10. Hold each strap hanger in position against the deck or bulkhead at right angles to the stud line.

11. Mark location for stud for opposite end of strap hanger using strap hanger as a template.

12. Remove strap hanger from studs.

13. Have welder end weld studs on deck or bulkhead in location marked in Step 11.

14. After cables are installed, install strap hangers over cables and studs and install washers and nuts on studs as shown in Fig. 20.

15. Tighten nuts on studs, using an end wrench.

METHOD BC

ALTERNATE METHOD OF SUPPORTING

CABLE HANGERS FOR METHODS C AND O

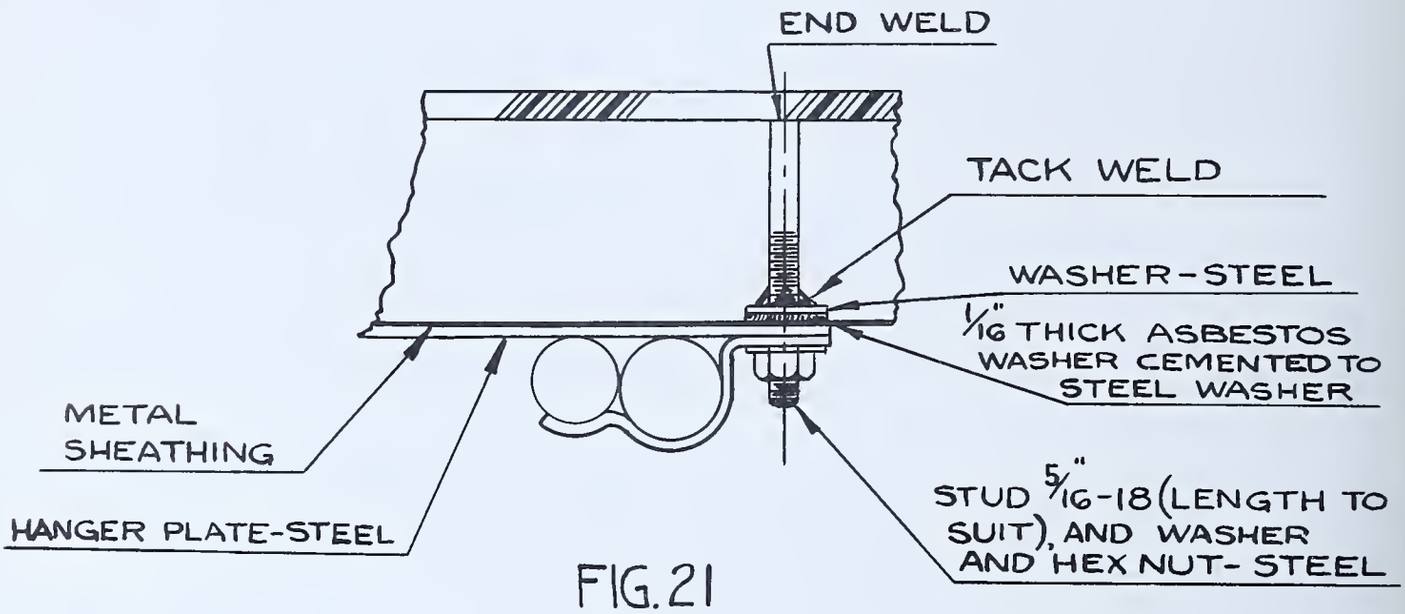

END WELD
TACK WELD
WASHER-STEEL
1/16" THICK ASBESTOS WASHER CEMENTED TO STEEL WASHER
METAL SHEATHING
HANGER PLATE-STEEL
STUD 5/16"-18 (LENGTH TO SUIT), AND WASHER AND HEX NUT- STEEL

FIG. 21

1. Determine the space requirements and location for the cable run to be installed on the deck or bulkhead.

2. Determine thickness of insulation. See Fig. 21.

3. Using a chalk line, strike stud lines (Fig. 21) for the full length of the run figured in Step 1.

   Note: The space between the lines is approximately 1" more than the space requirements for the cable, to allow for the head of the securing screw and the bend of the strap hanger on either side of the cable run.

4. Starting at a distance (away from each deck, bulkhead or equipment) to allow for bending radii of cables, center punch stud locations for first and last strap of run, along one stud line.

5. Determine and mark spacings between strap hangers, along the stud line selected in Step 4.

6. Center punch deck or bulkhead at intersections determined in Step 5.

7. Determine length of studs required (thickness of insulation plus $1\frac{1}{4}$").

   Note: The $1\frac{1}{4}$" is to allow for thickness of sheathing, hanger plate, strap hanger, washer and hexagon nut and an extension for ease in installing.

8. Draw from stock, stud bolts of sufficient length to suit dimension obtained in Step 7.

9. Obtain from stock two flat washers for 5/16" bolts for each stud (Step 8).

10. Measure distance from unthreaded end of each stud to point where flat washer is to be tack welded. See Fig. 21. Scribe a line.

    Note: This distance is equal to the thickness of insulation (Step 2) minus 1/16" (for asbestos washer) minus thickness of flat washer.

11. Hold flat washer in position on each stud at point determined in Step 10. and have welder tack weld washer to stud every 90°. See Fig. 21.

12. Have welder tack weld studs to the deck or bulkhead at each center punch mark along stud line (Step 6).

13. Select material and make strap hangers to suit cable run.

14. Select material and make hanger plates, using strap hangers as templates. See Fig. 21.

15. Insert a stud through one side of each hanger plate and install hexagon nut thereon.

16. Install hanger plates on studs welded to deck or bulkhead (Step 12).

17. Hold each hanger plate in position against the deck or bulkhead with a wooden stick or hammer handle, hanger plate to be at right angles to the stud line.

18. Have welder tack weld free studs to the deck or bulkhead.

19. Remove hanger plates and have welder end weld all studs. See Fig. 21.

20. Draw from stock or make 1/16" thick asbestos washers to fit on each washer that is tack welded to the studs. See Fig. 21.

21. Cement asbestos washer (Step 20) on each flat washer, using spar varnish or shellac.

22. After insulation has been installed and during installation of sheathing, have sheet metal worker template and drill holes in sheathing for studs.

23. After cables are installed, install hanger plates and strap hangers over cable and fasten to studs (See Fig. 21), using suitable washers and hexagon nuts.

METHOD CL

METHOD OF SUPPORTING ONE OR MORE CABLES ON ALUMINUM DECKS AND BULKHEADS HAVING INSULATION

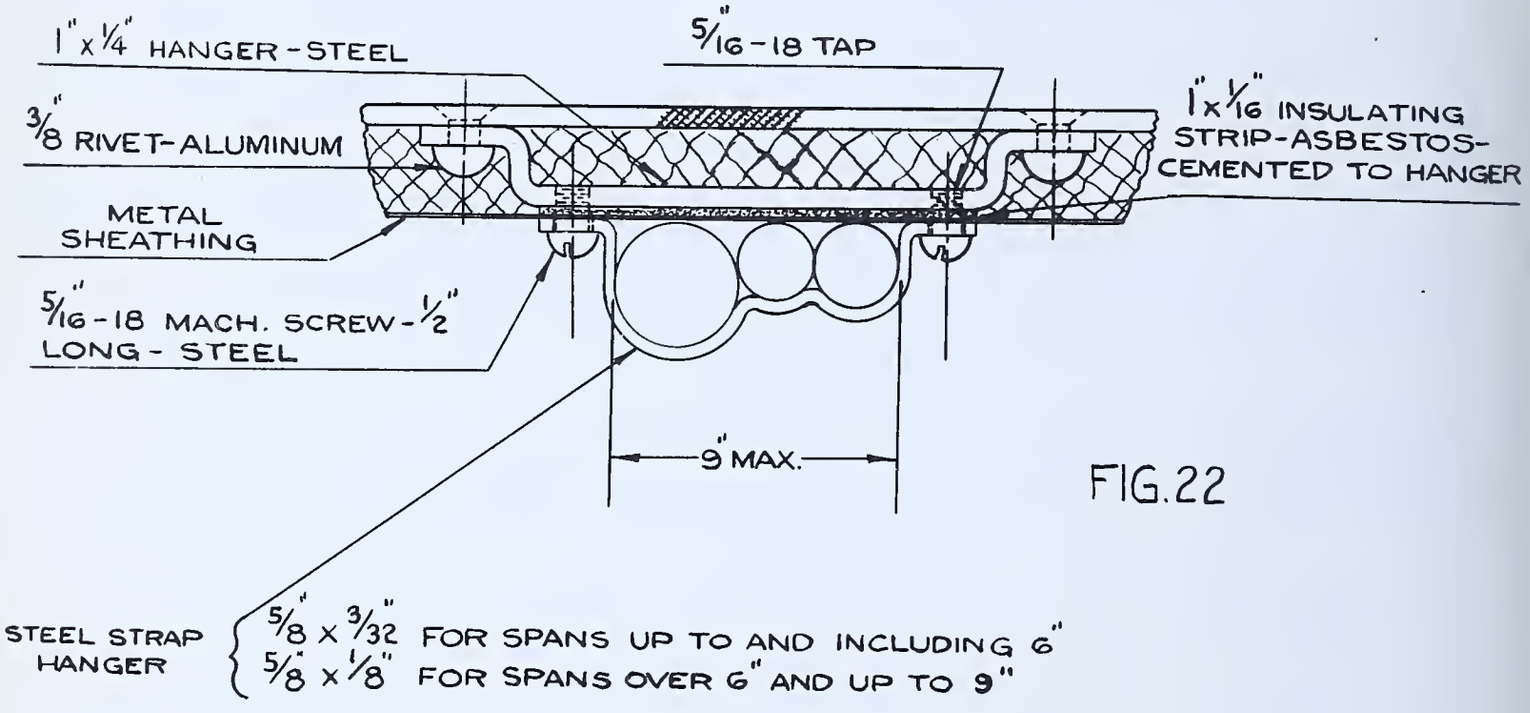

1" x 1/4" HANGER - STEEL
5/16 - 18 TAP
3/8" RIVET - ALUMINUM
1" x 1/16" INSULATING STRIP - ASBESTOS - CEMENTED TO HANGER
METAL SHEATHING
5/16" - 18 MACH. SCREW - 1/2" LONG - STEEL
9" MAX.
STEEL STRAP HANGER
5/8" x 3/32" FOR SPANS UP TO AND INCLUDING 6"
5/8" x 1/8" FOR SPANS OVER 6" AND UP TO 9"

FIG. 22

1. Determine the space requirements and location for the cable run to be installed on the deck or bulkhead.

2. Determine thickness of insulation. See Fig. 22.

3. Using a chalk line, strike rivet lines (Fig. 22) for the full length of the run figured in Step 1.

   Note: The space between the rivet lines is approximately 4" more than the space requirements for the cable, to allow for securing screws for strap hanger, bend of hanger material and rivet heads on either side of hanger. (See Fig. 22).

4. Starting at a distance (away from each deck, bulkhead or equipment) to allow for bending radii of cables, center punch rivet locations for first and last strap of run, along one rivet line.

5. Determine and mark spacings between strap hangers, along the rivet line selected in Step 4.

6. Center punch deck or bulkhead at intersections determined in Step 5.

7. Have driller drill and countersink deck or bulkhead for 3/8" flat head rivets at locations center punched in Step 5.

8. Select material and make strap hangers to suit cable runs.

9. Select 1" x 1/4" steel strap material of sufficient length, and manufacture hangers. (See Fig. 22).

   Note: Length of material required is approximately equal to over-all length of strap hanger (Step 8) plus twice the thickness of insulation (Step 2) plus 3/8".

   The 3/8" is obtained by adding four times the thickness of the hanger (1") and two times the thickness of the asbestos washer (1/8"), and subtracting this total from 3/4" on each end for rivet heads ($1\frac{1}{2}$").

10. Secure one end of each hanger plate to the deck or bulkhead, using suitable round head machine screws and nuts.

11. Hold each hanger against the deck or bulkhead at right angles to the rivet lines (Step 3), mark and center punch the deck or bulkhead at the center location of the hole in the free end of each hanger.

12. Have driller drill and countersink deck or bulkhead for 3/8" flat head rivets at locations center punched in Step 11.

13. Install machine screws through remaining holes in hanger and holes in deck or bulkhead (Step 12) and install nuts thereon.

14. Center a strap hanger (Step 8) on the first and last hanger in the run, mark and center punch the hanger at the center locations of the holes in the strap hanger.

15. Stretch a chalk line tightly between the center punch marks on the first and last hanger (Step 14) and strike a line for the securing screws of the strap hangers.

16. Center punch each hanger at the securing screw lines (Step 15).

17. Remove machine screws, nuts and hanger from the deck or bulkhead.

18. Drill and tap each hanger for 5/16"-18 machine screw, at center punch marks (Step 16).

19. Determine the number of round head machine screws required and draw from stock.

20. Secure one side of strap hanger to each hanger, using round head machine screws.

21. Hold strap hanger securely against each hanger (parallel to the sides of the hanger), mark and center punch the hanger at the center location of the hole in the free end of each strap hanger.

22. Drill and tap each hanger for 5/16"-18 machine screw, at center punch marks (Step 21).

23. Remove round head machine screws and strap hanger from each hanger.

24. Have hangers riveted to deck or bulkhead in locations of drilled holes (Steps 7 and 12) as shown in Fig. 22.

25. Make 1" x 1/16" asbestos washers, using base of strap hangers as templates. See Fig. 22.

26. Cement washer (Step 25) on each hanger, using spar varnish or shellac.

27. After insulation has been installed and during installation of sheathing, have sheet metal worker template and drill holes in sheathing to permit installation of machine screws in hangers.

28. After cables are installed, install strap hangers over cable and fasten to hanger (See Fig. 22) using 5/16"-18 steel machine screws (1/2" long) fitted with shakeproof washers.

METHOD ELL

METHOD OF SUPPORTING A SINGLE ROW OF CABLES

ON ALUMINUM DECKS AND BULKHEADS (W. T.)

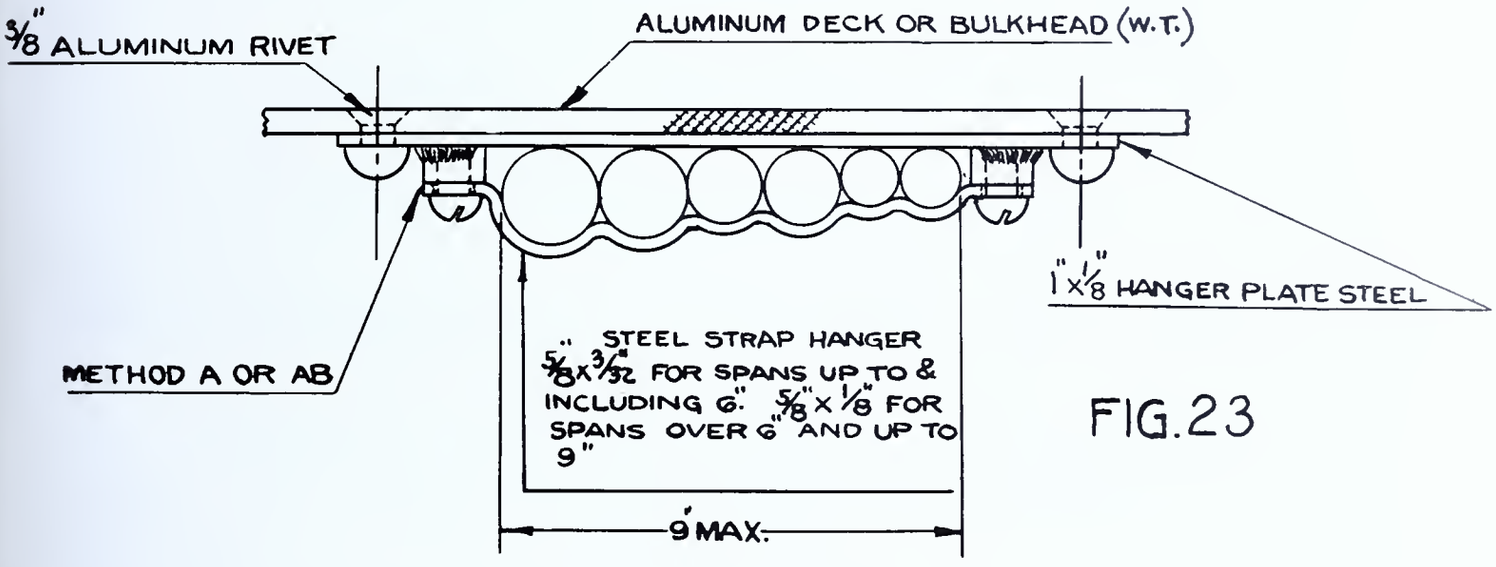

3/8" ALUMINUM RIVET
ALUMINUM DECK OR BULKHEAD (W.T.)
1"x1/8" HANGER PLATE STEEL
METHOD A OR AB
5/8" STEEL STRAP HANGER 5/8"x3/32" FOR SPANS UP TO & INCLUDING 6". 5/8"x1/8" FOR SPANS OVER 6" AND UP TO 9"
9" MAX.

FIG.23

1. Determine the space requirements and location for the cable run to be installed on the deck or bulkhead.

2. Using a chalk line, strike rivet lines for the full length of the runs figured in Step 1.

   Note: The space between rivet lines is approximately 3" more than the space requirements for the cable, to allow for welding of pads or studs on hanger plate and clearance for rivet heads. See Fig. 23.

3. Starting at a distance (away from each bulkhead, deck or equipment) to allow for bending radii of cables, center punch rivet locations for first and last strap of run, along one rivet line.

4. Determine and mark spacings between strap hangers, along the rivet line selected in Step 3.

5. Center punch deck or bulkhead at intersections determined in Step 4.

6. Have driller drill and countersink deck or bulkhead for 3/8" flat head rivets at locations center punched in Step 5.

7. Select material and make strap hangers to suit cable runs.

8. Select 1" x 1/8" steel strap material of sufficient length, and manufacture hanger plates. See Fig. 23.

   Notes: (a) Length of material required is approximately 4" longer than width requirements of cable run.

   (b) A 13/32" hole must be drilled 1/2" from each end of each hanger plate.

9. Secure one end of each hanger plate to the deck or bulkhead, using suitable round head machine screws and nuts.

10. Hold each hanger plate against the deck or bulkhead at right angles to the rivet lines (Step 2), mark and center punch the deck or bulkhead at the center location of the hole in the free end of each hanger plate.

11. Have driller drill and countersink deck or bulkhead for 3/8" flat head rivets at locations center punched in Step 10.

12. Install machine screws through remaining holes in hanger plate and holes in deck or bulkhead (Step 11), and install nuts thereon.

13. Center a strap hanger (Step 7) on the first and last hanger plate in the run, mark and center punch the hanger plate at the center locations of the holes in the strap hanger.

14. Stretch a chalk line tightly between the center punch marks on the first and last hanger plates (Step 13), and strike one pad or stud line on all hanger plates.

15. Center punch each hanger plate at the pad or stud lines (Step 14).

16. Remove machine screws, nuts and hanger plates from the deck or bulkhead.

A. WHERE STRAP HANGERS ARE TO BE MOUNTED ON PADS

17. Determine the number of steel pads required and draw from stock.

18. Secure a steel pad to each side of each strap hanger, using a round head machine screw.

19. Center the strap hangers on the hanger plates (one pad on center punch mark Step 15), and have welder tack weld pads to hanger plates.

20. Remove round head machine screws and strap hanger from each hanger plate and have welder fillet weld pad for 270° angle on opposite side of cable run. See Fig. 23.

B. WHERE STRAP HANGERS ARE TO BE MOUNTED ON STUDS

17. Determine the number and length of studs and nuts required and draw from stock.

18. Have welder end weld studs to each hanger plate at locations center punched in Step 15.

19. Mark location on hanger plate for stud for opposite end of strap hanger, using strap hanger as a template.

20. Remove strap hanger from stud.

21. Have welder end weld studs on hanger plate in location marked in Step 19.

22. Have hanger plates riveted to deck or bulkhead in locations of drilled holes (Steps 6 and 11) as shown in Fig. 23.

23. After cables are installed, install strap hangers over cables and secure to pads using round head machine screws fitted with shakeproof washers or to studs using washers and hexagon nuts.

24. Tighten screws with screw driver, or hexagon nuts with an end wrench.

METHOD X

METHOD OF SUPPORTING CABLES ON STANCHION

(For Alternate See Method AB)

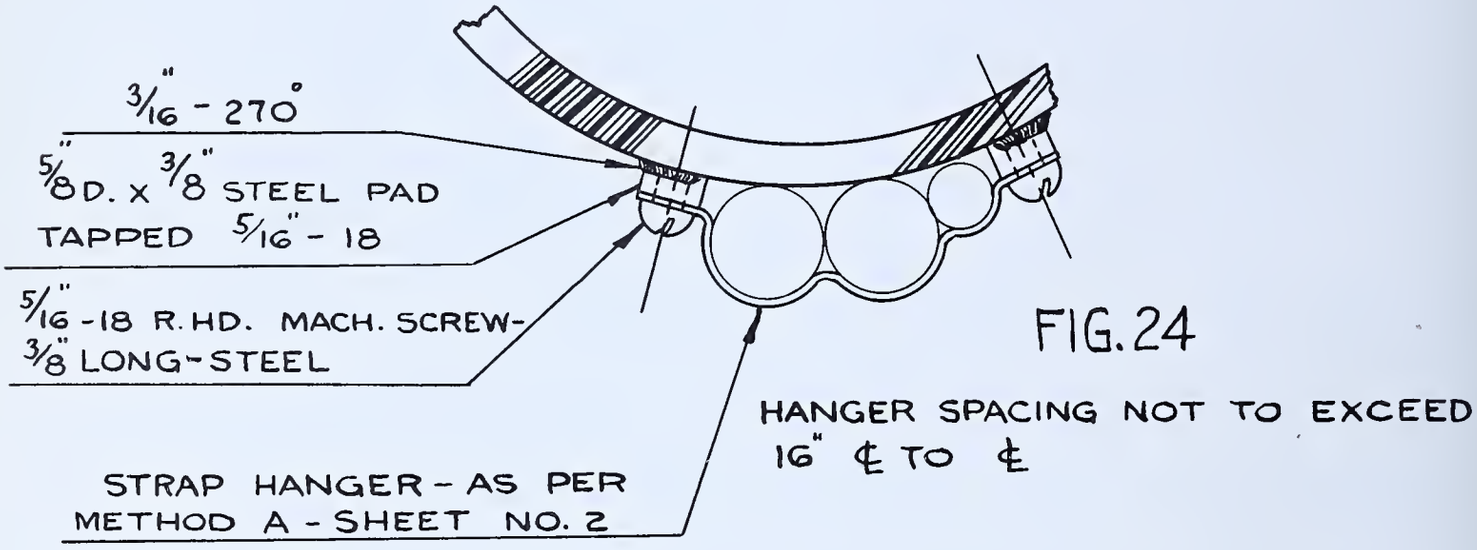

3/16" - 270°
5/8" D. x 3/8" STEEL PAD TAPPED 5/16" - 18
5/16" - 18 R.HD. MACH. SCREW - 3/8" LONG - STEEL
STRAP HANGER - AS PER METHOD A - SHEET NO. 2
HANGER SPACING NOT TO EXCEED 16" ℄ TO ℄

FIG. 24

NOTE :-
FOR SUPPORTING SINGLE CABLES ON STEEL STANCHION, USE METHOD R & S.

1. Determine the space requirements and select location for the cable run to be installed on the stanchion.

2. Using a chalk line, strike pad lines for the full length of the run figured in Step 1.

   Note: The space between pad lines is approximately 1" more than the space requirements for the cable, to allow for the pad and bend of the strap hanger on either side of the cable run.

3. Starting at a distance (away from the top or bottom of stanchion or equipment installed thereon) to allow for bending radii of cables, center punch pad locations for first and last strap of run, along one pad line.

4. Determine and mark spacings between strap hangers, along the pad line selected in Step 3.

5. Center punch stanchion at intersections determined in Step 4.

6. Determine number of steel pads required and draw from stock.

7. Using the pad holder, have welder tack weld the pads to the stanchion at each center punch mark along the pad line (Step 5).

8. Select material and make strap hangers to suit cable run.

9. Secure a steel pad to one side of each strap hanger, using a round head machine screw.

10. Secure strap hangers to pads welded to stanchion (Step 7) using round head machine screws.

11. Hold each strap hanger in position against the stanchion with a wooden stick or hammer handle, strap hanger to be at right angles to the pad line.

12. Have welder tack weld free pads to stanchion.

13. Remove strap hangers from pads and have welder fillet weld pad for 270° angle on opposite side of cable run. See Fig. 24.

14. After cables are installed, install strap hangers over cable and fasten to the pads, using round head machine screws fitted with shakeproof washers.

METHOD D

METHOD OF SUPPORTING MULTIPLE ROWS OF CABLES TO VARIOUS TYPES OF DECKS AND BULKHEADS

In main wireways, where the span of the cable run exceeds 15", multiple rows of one or more tiers are installed.

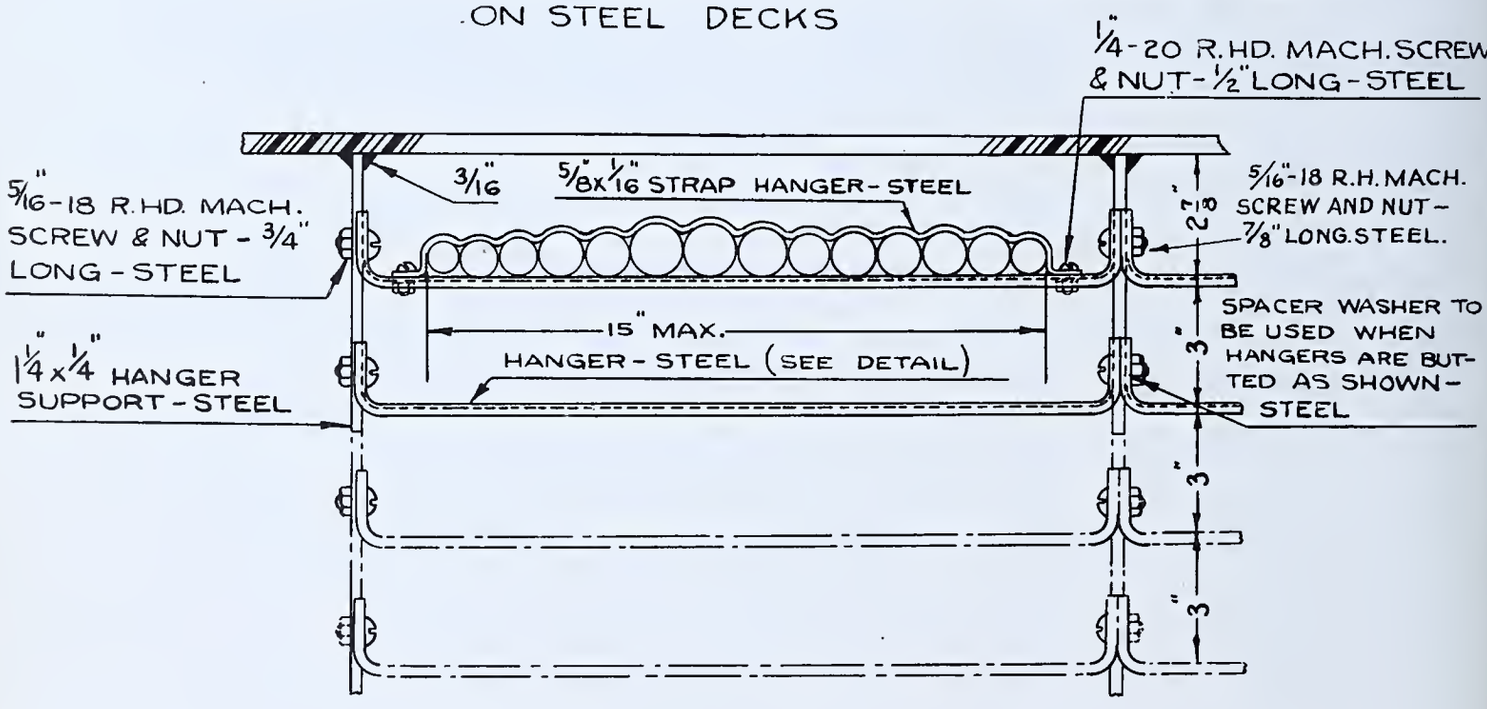
"Multiple rows" are installed side by side at the same distance from the deck or bulkhead.

"Tiers" are built upon the same "row" and are usually limited to five (5) in number.

Typical methods of supporting multiple rows of cables are shown in figures 25, 26, 27, 28 and 29.

METHOD "D"

METHOD OF SUPPORTING MULTIPLE ROWS OF CABLES ON STEEL DECKS


1"/4-20 R.HD. MACH. SCREW & NUT-1/2" LONG-STEEL
5/16"-18 R.HD. MACH. SCREW & NUT - 3/4" LONG - STEEL
3/16"
5/8"x1/16" STRAP HANGER-STEEL
5/16"-18 R.H. MACH. SCREW AND NUT - 7/8" LONG.STEEL.
2 1/2"
15" MAX.
HANGER - STEEL (SEE DETAIL)
1 1/4"x1/4" HANGER SUPPORT - STEEL
SPACER WASHER TO BE USED WHEN HANGERS ARE BUTTED AS SHOWN - STEEL
3"
3"
3"

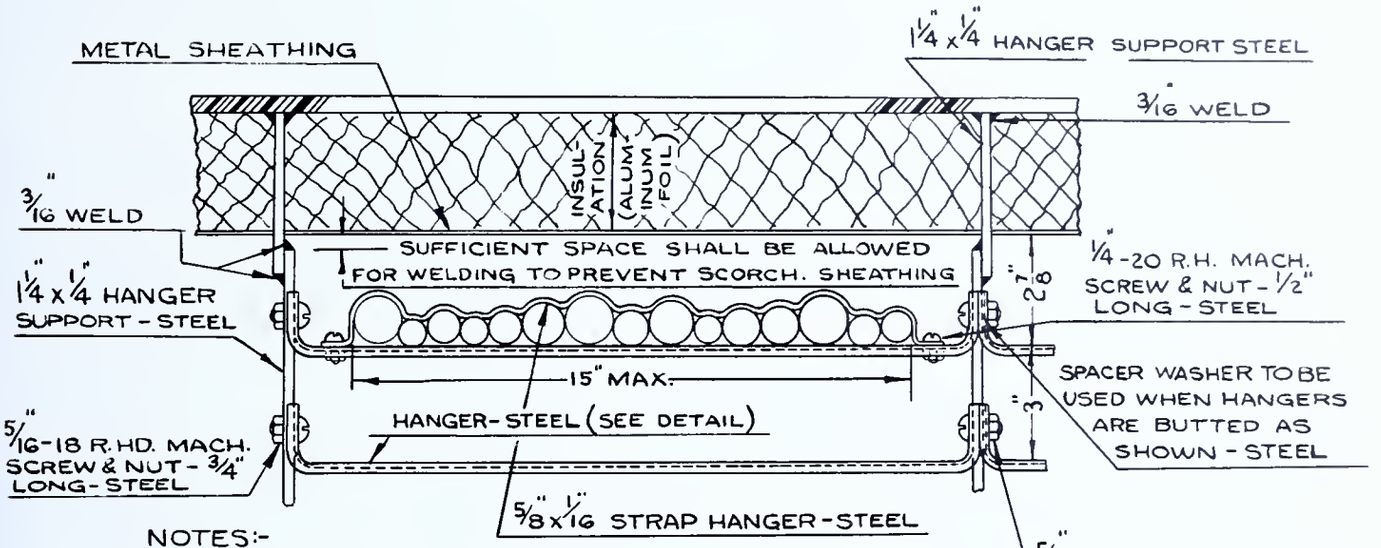
NOTES:-

1. MULTIPLE TIERS OF CABLE SHALL NOT EXCEED FIVE.
2. HANGER SPACING SHALL NOT EXCEED 16" ℄ TO ℄
3. 5/8" x 1/16" STEEL STRAP HANGER, EVERY 8TH HANGER & AT EACH HANGER AT BENDS.

FIG.-25

METHOD "E"

METHOD OF SUPPORTING MULTIPLE ROWS OF CABLES ON STEEL DECKS HAVING INSULATION


METAL SHEATHING
1¼" x ¼" HANGER SUPPORT STEEL
3/16" WELD
INSULATION (ALUMINUM FOIL)
3/16" WELD
SUFFICIENT SPACE SHALL BE ALLOWED FOR WELDING TO PREVENT SCORCH. SHEATHING
1¼" x ¼" HANGER SUPPORT - STEEL
¼"-20 R.H. MACH. SCREW & NUT - ½" LONG - STEEL
2⅞"
15" MAX.
SPACER WASHER TO BE USED WHEN HANGERS ARE BUTTED AS SHOWN - STEEL
3"
5/16"-18 R.HD. MACH. SCREW & NUT - ¾" LONG - STEEL
HANGER - STEEL (SEE DETAIL)
⅝" x 1/16" STRAP HANGER - STEEL
5/16"-18 R.H. MACH. SCREW & NUT - ⅞" LONG - STEEL

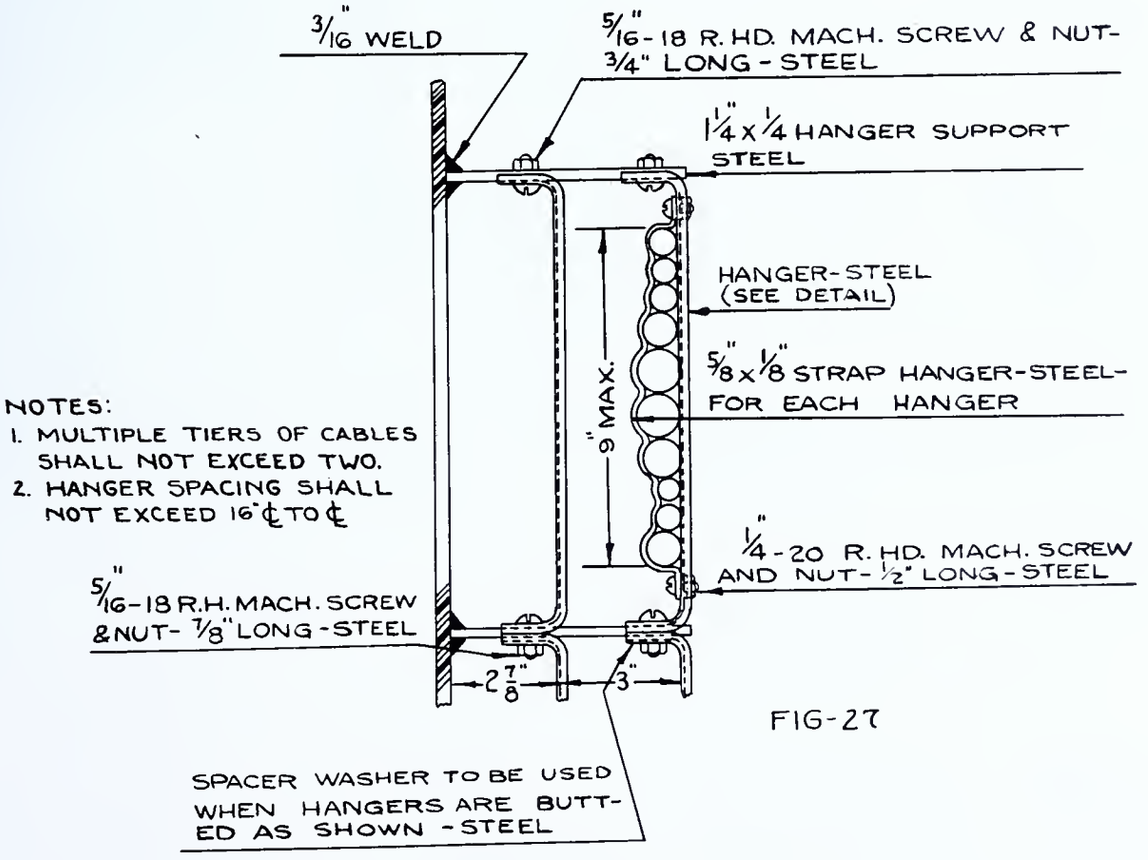
NOTES:-

1. MULTIPLE TIERS OF CABLES SHALL NOT EXCEED FIVE.
2. HANGER SPACING SHALL NOT EXCEED 16" ℄ TO ℄. 3. ⅝" x 1/16" STEEL STRAP HANGER, EVERY 8TH HANGER & AT EACH HANGER AT BENDS.

FIG.-26

METHOD "F"

METHOD OF SUPPORTING TWO ROWS OF CABLES ON STEEL BULKHEADS


3/16" WELD
5/16"-18 R.HD. MACH. SCREW & NUT - ¾" LONG - STEEL
1¼" x ¼" HANGER SUPPORT STEEL
HANGER - STEEL (SEE DETAIL)
⅝" x ⅛" STRAP HANGER - STEEL - FOR EACH HANGER
9" MAX.
¼"-20 R.HD. MACH. SCREW AND NUT - ½" LONG - STEEL
5/16"-18 R.H. MACH. SCREW & NUT - ⅞" LONG - STEEL
2⅞"
3"
SPACER WASHER TO BE USED WHEN HANGERS ARE BUTTED AS SHOWN - STEEL

NOTES:

1. MULTIPLE TIERS OF CABLES SHALL NOT EXCEED TWO.
2. HANGER SPACING SHALL NOT EXCEED 16" ℄ TO ℄

FIG-27

METHOD "G"

METHOD OF SUPPORTING TWO ROWS OF CABLES ON STEEL BULKHEADS HAVING INSULATION

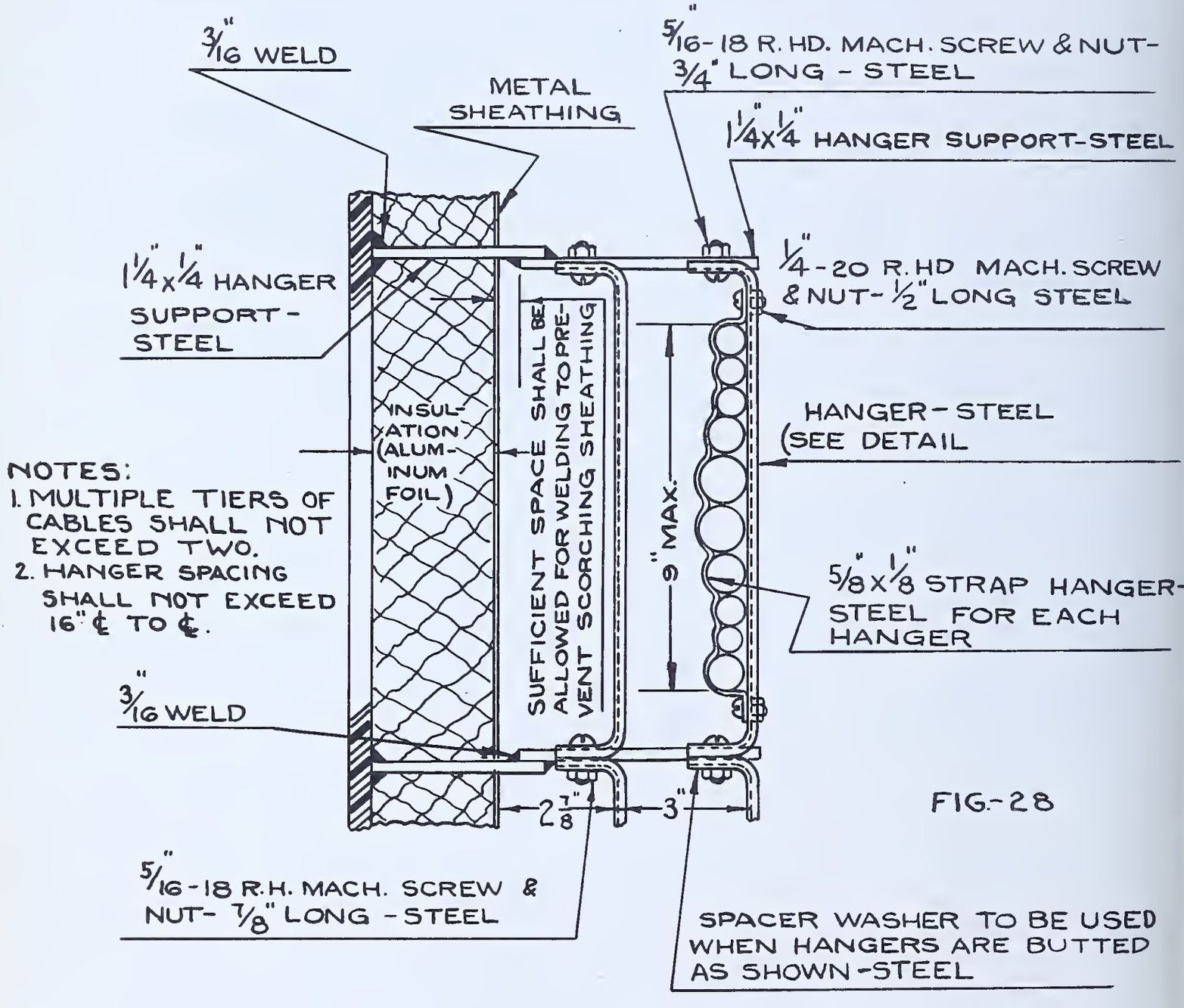
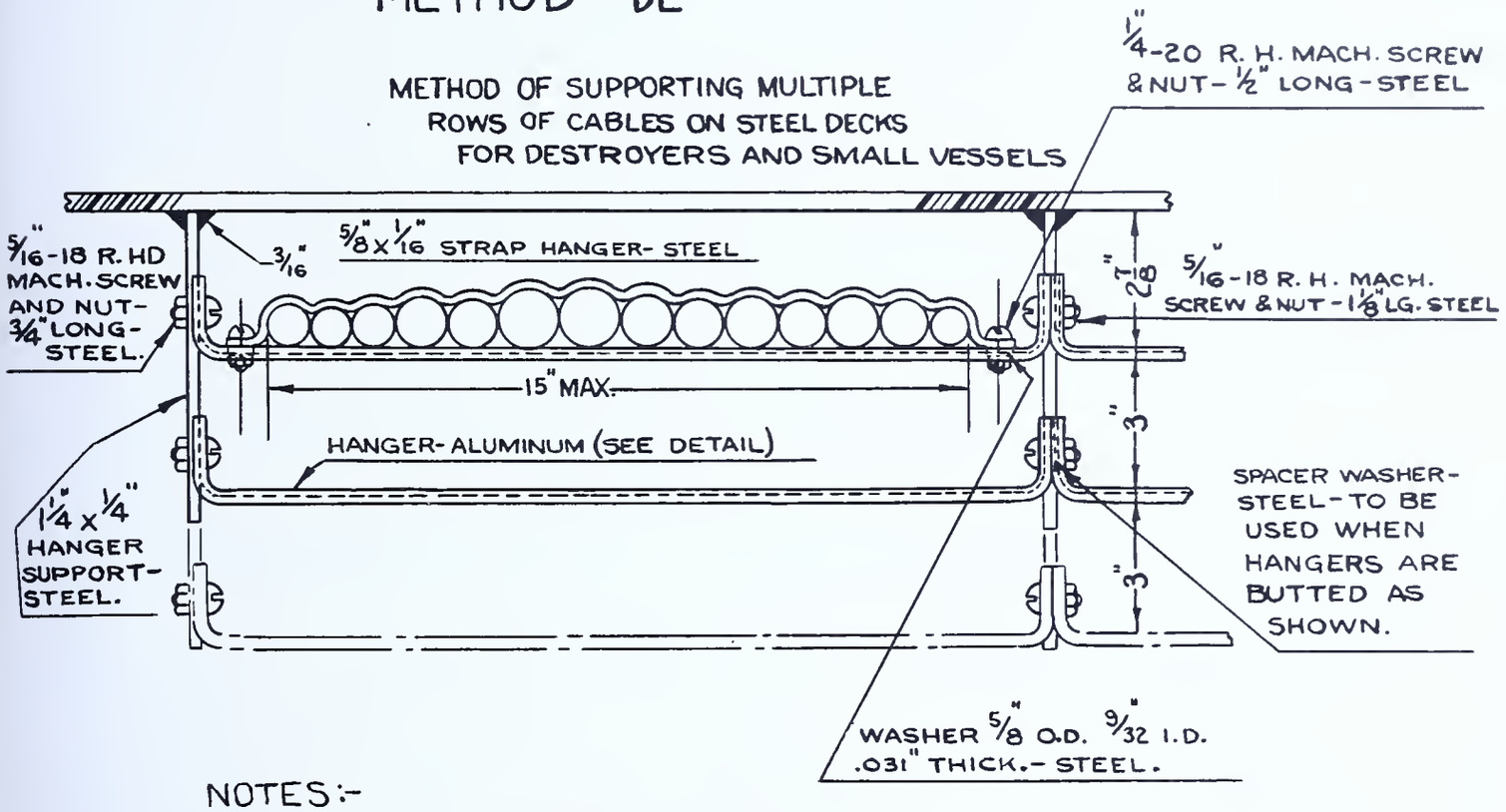

3/16" WELD
METAL SHEATHING
5/16-18 R. HD. MACH. SCREW & NUT- 3/4" LONG - STEEL
1 1/4 x 1/4 HANGER SUPPORT-STEEL
1/4-20 R. HD MACH. SCREW & NUT- 1/2" LONG STEEL
1 1/4 x 1/4 HANGER SUPPORT - STEEL
INSULATION (ALUMINUM FOIL)
SUFFICIENT SPACE SHALL BE ALLOWED FOR WELDING TO PREVENT SCORCHING SHEATHING
9" MAX.
HANGER - STEEL (SEE DETAIL
NOTES:
1. MULTIPLE TIERS OF CABLES SHALL NOT EXCEED TWO.
2. HANGER SPACING SHALL NOT EXCEED 16" ℄ TO ℄.
5/8 x 1/8 STRAP HANGER-STEEL FOR EACH HANGER
3/16" WELD
2 1/8"
3"
5/16-18 R.H. MACH. SCREW & NUT- 7/8" LONG - STEEL
SPACER WASHER TO BE USED WHEN HANGERS ARE BUTTED AS SHOWN - STEEL

FIG.-28

METHOD "DL"


METHOD OF SUPPORTING MULTIPLE ROWS OF CABLES ON STEEL DECKS FOR DESTROYERS AND SMALL VESSELS
1" 1/4-20 R. H. MACH. SCREW & NUT - 1/2" LONG - STEEL
5/16" - 18 R. HD MACH. SCREW AND NUT - 3/4" LONG - STEEL.
3/16"
5/8" X 1/16" STRAP HANGER - STEEL
5/16" - 18 R. H. MACH. SCREW & NUT - 1 1/8" LG. STEEL
2 7/8"
15" MAX.
3"
HANGER - ALUMINUM (SEE DETAIL)
1 1/4" X 1/4" HANGER SUPPORT - STEEL.
SPACER WASHER - STEEL - TO BE USED WHEN HANGERS ARE BUTTED AS SHOWN.
3"
WASHER 5/8" O.D. 9/32" I.D. .031" THICK. - STEEL.

NOTES:-

1. MULTIPLE TIERS OF CABLES SHALL NOT EXCEED FIVE
2. HANGER SPACING NOT TO EXCEED 16" ℄ TO ℄
3. 5/8" X 1/16" STEEL STRAP HANGER, EVERY 8TH. HANGER AND AT EACH HANGER AT BENDS.

FIG-29

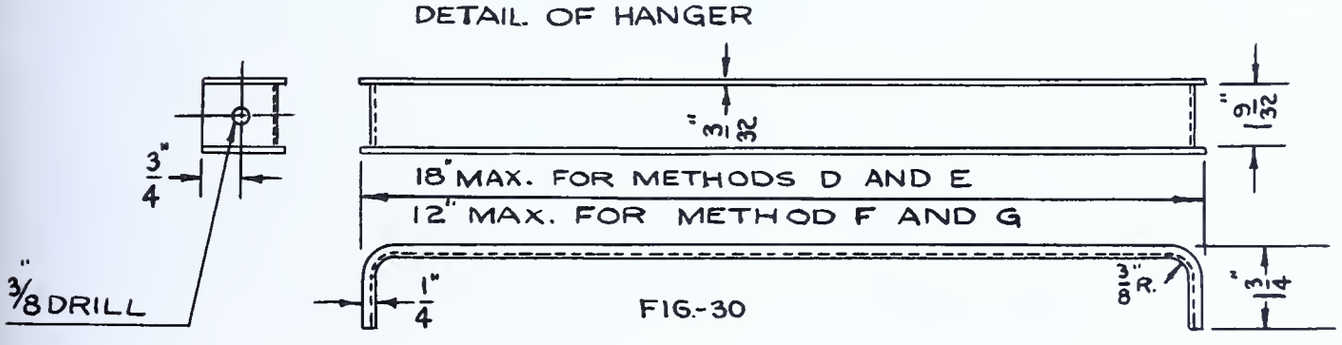


FIG.-30

QUESTIONS

Place the answers to these questions in your notebook or on form as directed by instructor.

1. Why are cable straps and hangers installed?

2. What is the approximate distance between straps or hangers?

3. What factors determine the location of wireways and cable runs?

4. What determines the bend in the cable runs?

5. Why is a chalk line used in installing hanger supports?

6. How are lengths of strap material determined?

7. Outline briefly the steps required to make a cable strap for more than two cables.

8. What type strap is required to secure a single cable to a deck or bulkhead having insulation?

9. What type strap is required to secure a single cable (under 1" diameter) to a deck or bulkhead without insulation?

10. What is a "pad" and why is it used?

11. What is the maximum limit for a single span of cable on a deck or bulkhead?

12. What means of support are used for cables secured to deck and bulkheads subjected to excessive moisture or to avoid an obstruction?

13. What is a "stool" and where is it used?

14. (a) What is the maximum span of cables permitted under one strap in main wireways?
    (b) When span exceeds this limit, what methods of supporting cables in the same rack are employed?

15. Outline the steps required for determining and securing a wireway for a single run of cables on a watertight steel bulkhead.

PART VI

INSTALLATION JOBS

UNIT 22 — DESCRIPTION OF TYPICAL MARINE ELECTRICAL DRAWINGS — Page 240

UNIT 23 — CONSTRUCTION DRAWINGS AND JOB BREAKDOWNS — Page 245

Drawing 3 — Officers' Call Bell System — I. C. Circuit "A" — Page 245

Drawing 4 — Sound Powered Telephone Systems — I. C. Circuit "JX" — Page 254

Drawings 5A and 5B — Sound Powered Telephone Call Bell System — Circuit "E" — Page 271

Drawings 6A and 6B — General Lighting System — Page 283

Drawing 7 — Power Distribution System — Page 313

Drawings 8A and 8B — Running, Anchor, and Signal Light System — Page 332

Drawings 9, 10A, 10B and 10C — Combined Electrical Installations — Page 337

DESCRIPTION OF

TYPICAL MARINE ELECTRICAL DRAWINGS

Marine Electrical Drawings consist chiefly of three different types:

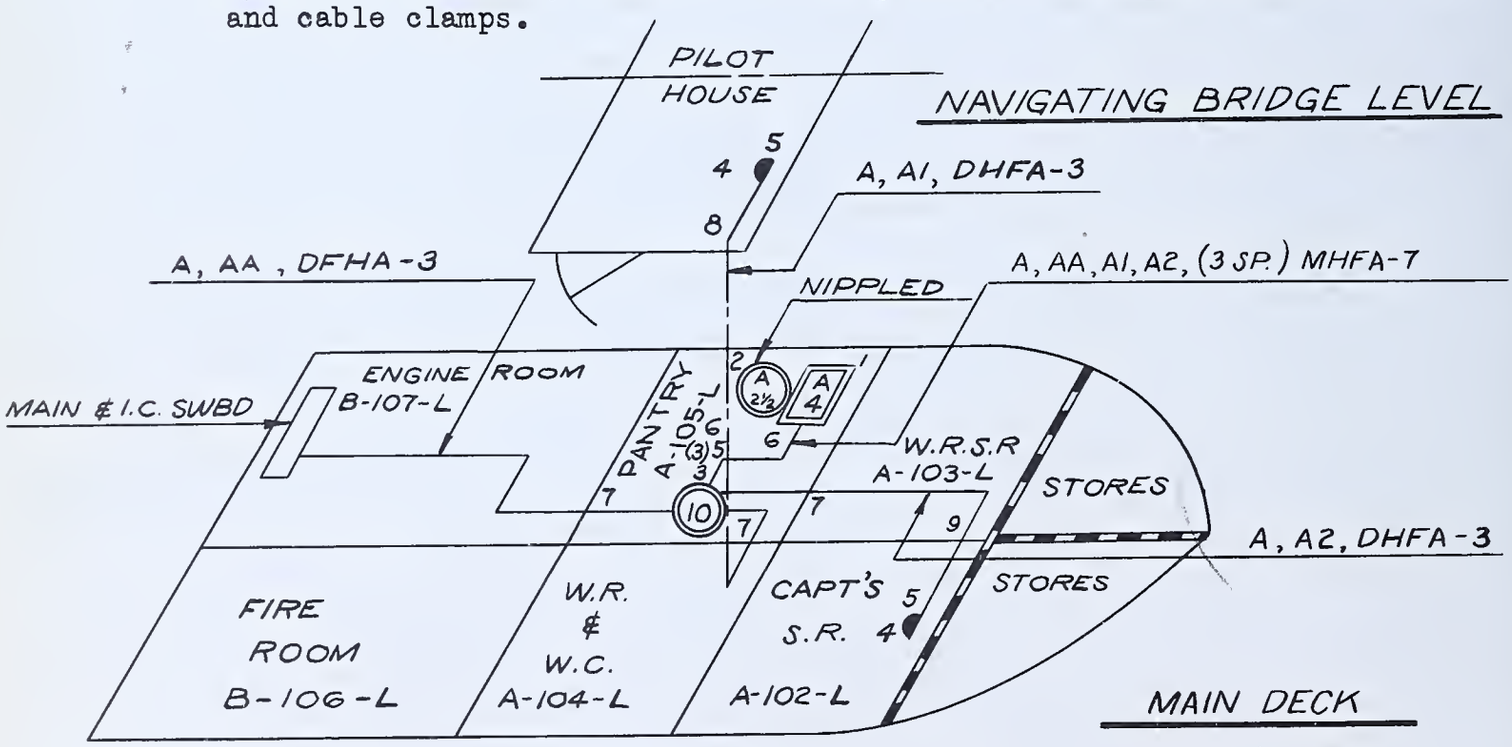
1. Isometric Wiring Diagrams
2. Elementary Wiring Diagrams
3. Deck Plans

1. Isometric Wiring Diagrams show athwartship members tilted 30° from the vertical plane. The purpose of this distortion is to permit the continuous representation of cable passing between decks.

Decks are named, and compartments are marked as to their name and number. Watertight or non-watertight bulkheads, decks, or compartments may or may not be so indicated on the plan.

Isometric Wiring Diagrams are the actual installation diagrams and are used for such systems as Interior Communication systems. They show continuous runs of cable from the origin to the terminal points, and the equipment and material at all points.

This type of drawing provides a bill of material which lists all material and equipment required to complete the installation, with the exception of cable, wire terminals and lugs. Equipments and materials in the bill of material are assigned symbols and symbol numbers. These symbols and symbol numbers are also indicated on the wiring plan. Symbol numbers only indicate stuffing tubes, bushings, terminal tubes and cable clamps.



INTERIOR COMMUNICATION SYSTEM
SIMPLIFIED ISOMETRIC WIRING DIAGRAM

FIG-1

Notes: 1. Stuffing tubes are used in watertight bulkheads and decks. Bushings are used in non-watertight bulkheads and decks.

2. Terminal tubes are used in watertight equipment and cable clamps are used in non-watertight equipment.

On interior communication and similar systems the section wire numbers are indicated at each cable to assist the electrician in associating each circuit with the elementary wiring diagram.

Note: See Figs. 1 and 2.

Isometric wiring diagrams of lighting and power circuits for Navy work are usually used to indicate main supply cables and equipment and sub-main circuits.

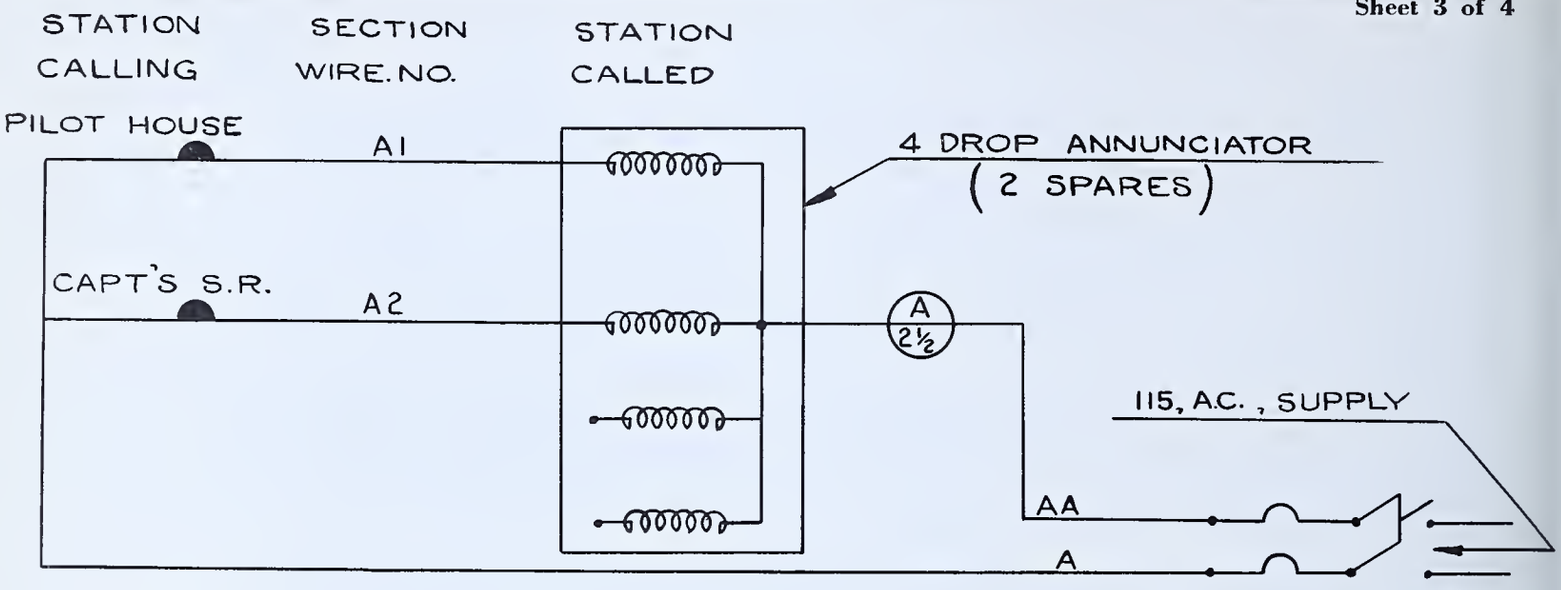
A simplified isometric wiring diagram of an interior communication system is shown in Fig. 1.

2. Elementary Wiring Diagrams are used in connecting the section wires in each cable. These diagrams may or may not indicate the various connection boxes through which the cables pass, but in either case they show a continuous circuit from the source to equipment used.

Elementary Wiring Diagrams of interior communication and similar systems have the section wires indicated to conform with the isometric wiring diagrams. This type of drawing for alternating current lighting and power systems indicates the phase to which the equipment is to be attached.

The interiors of fittings, fixtures, and appliances are also shown, to indicate the connections, fusing, and switching of the circuits.

A simplified elementary wiring diagram of the interior communication system (Fig. 1) is shown in Fig. 2.



INTERIOR COMMUNICATION — SIMPLIFIED ELEMENTARY WIRING DIAGRAM

FIG.-2

3. Deck Plans do not distort the athwartship members but represent a true plan. These plans are subdivided into two main groups in Navy marine electrical work:

(a) Lighting and Power System Deck plans are the actual installation diagrams for the particular deck illustrated.

For these systems, the bill of material on the plan lists all material and equipment required to complete the installation on the deck concerned.

Equipments and materials, except cable, are assigned symbols and symbol numbers and are so indicated on the diagram and in the bill of material.

Lighting and power circuits, in alternating current work, have indicated at each single phase fixture, fitting or appliance the phase to which it is to be connected; i.e., AB phase, BC phase, or CA phase. Equipments not so indicated are three-phase and need not to be indicated.

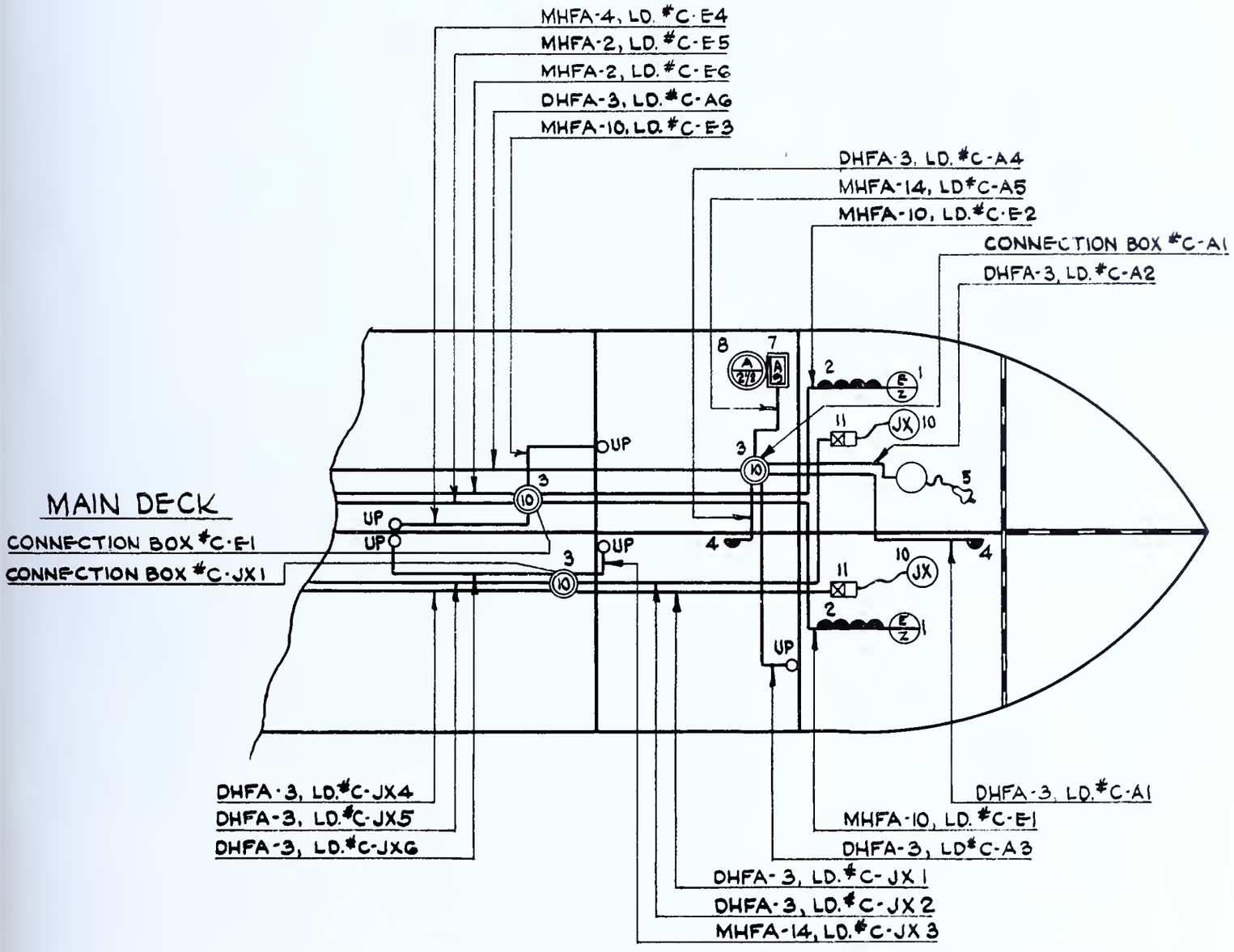
(b) Interior Communication and similar type Deck Plans are information plans only, and are merely a composite of all like systems; that is, all interior communication systems on a ship are indicated on an interior communication deck plan, etc.

For these systems, a list of symbols replaces the bill of material.

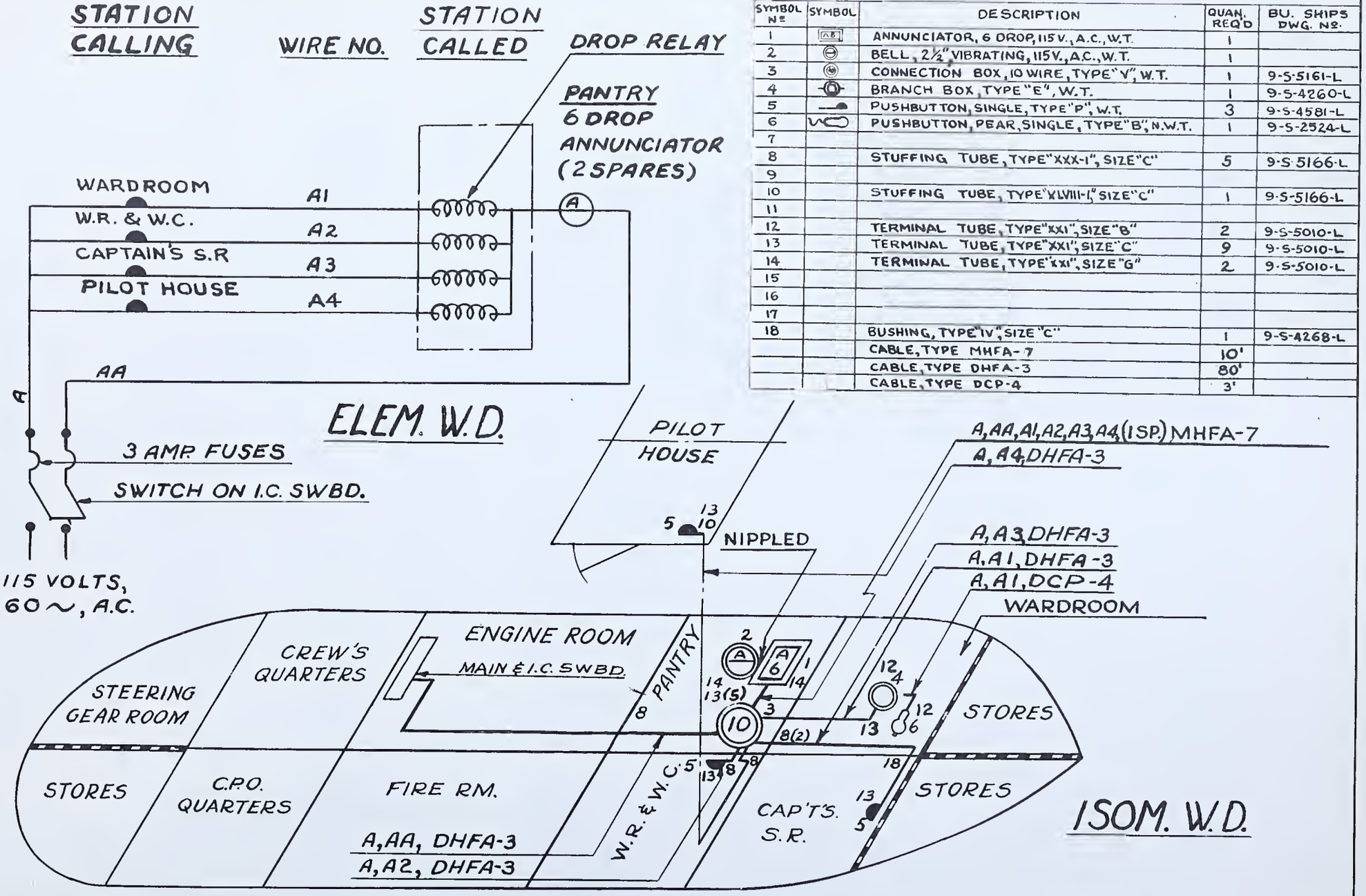
Symbols and symbol numbers are shown on the plan but unlike the isometric, the section wires of the cables are not indicated.

This type of plan enables the electrician to lay out his work for a number of cables without referring to each individual isometric wiring diagram.

A partial deck plan is shown in Fig. 3.



PARTIAL DECK PLAN INTERIOR COMMUNICATION SYSTEM
FIG. 3



LIST OF MATERIAL

SYMBOL Nº	SYMBOL	DESCRIPTION	QUAN. REQ'D	BU. SHIPS DWG. Nº.
1		ANNUNCIATOR, 6 DROP, 115 V., A.C., W.T.	1	
2		BELL, 2½" VIBRATING, 115 V., A.C., W.T.	1	
3		CONNECTION BOX, 10 WIRE, TYPE "Y", W.T.	1	9-S-5161-L
4		BRANCH BOX, TYPE "E", W.T.	1	9-S-4260-L
5		PUSHBUTTON, SINGLE, TYPE "P", W.T.	3	9-S-4581-L
6		PUSHBUTTON, PEAR, SINGLE, TYPE "B", N.W.T.	1	9-S-2524-L
7				
8		STUFFING TUBE, TYPE "XXX-1", SIZE "C"	5	9-S-5166-L
9				
10		STUFFING TUBE, TYPE "XLVIII-1", SIZE "C"	1	9-S-5166-L
11				
12		TERMINAL TUBE, TYPE "XXI", SIZE "B"	2	9-S-5010-L
13		TERMINAL TUBE, TYPE "XXI", SIZE "C"	9	9-S-5010-L
14		TERMINAL TUBE, TYPE "XXI", SIZE "G"	2	9-S-5010-L
15				
16				
17				
18		BUSHING, TYPE "IV", SIZE "C"	1	9-S-4268-L
		CABLE, TYPE MHFA-7	10'	
		CABLE, TYPE DHFA-3	80'	
		CABLE, TYPE DCP-4	3'	

OFFICER'S CALL-BELL SYSTEM - I.C. CIRCUIT "A" - ELEM & ISOM. W.D.

MARINE ELECTRICAL DRAWING Nº. 3

OFFICERS' CALL BELL SYSTEM - CIRCUIT "A"

MARINE ELECTRICAL DRAWING NO. 3

List of Jobs

Note: Actual cable lengths may be determined by trainees in each job or by those doing Job 5, at the discretion of the instructor.

JOB 1. Install pushbutton and associated cable in Captain's Stateroom.

Procedure:

1. Drill, tap and insert a terminal tube for Type DHFA-3 cable in the "boss" of the pushbutton.
2. Select location, spot, center punch and have the forward end of the inboard bulkhead drilled for a bushing for DHFA-3 cable.
3. Install a bushing in the hole in the inboard bulkhead.
4. Mount the pushbutton on the forward bulkhead, midway between the inboard and outboard bulkheads.
5. Figure the run of the cable from the inboard bulkhead to the pushbutton, along the forward bulkhead.
6. Pull DHFA-3 cable through the bushing.
7. Prepare the end of the cable and insert it through the terminal tube into the pushbutton.
8. Install two-eared cable straps over the cable and secure to the forward bulkhead along the run determined in Step 5.
9. Take up the slack cable, passing the excess cable through the bushing into the adjacent compartment.
10. Pack the terminal tube.
11. Tighten the cable straps.
12. Install lugs and connect section wires of the DHFA-3 cable to the pushbutton as shown in the elementary wiring diagram of Drawing 3.
13. Assemble the pushbutton.

JOB 2. Install a pear-type pushbutton and a branch box in the Wardroom and install all wiring associated with the system.

Procedure:

1. Drill and tap center location of the cover of the branch box for a terminal tube for DCP-4 cable.

2. Install a terminal tube in the tapped hole in the cover of the branch box.

3. Select horizontal adjacent locations, mark, center punch and have the inboard side of the after bulkhead drilled for two stuffing tubes for DHFA-3 cable.

4. Install stuffing tubes in the drilled holes in the after bulkhead.

5. Spot the center of the compartment location and mount the branch box on pads on the overhead.

6. Figure the runs of cable on the overhead from the after bulkhead to the bushings in the inboard bulkhead and to the branch box.

7. Spot locations and have pads for two-eared cable straps welded to the overhead from the after bulkhead to the point where the cable runs divide, along the run determined in Step 6.

8. Spot locations and have pads for one-eared cable straps welded to the overhead from the point where the cables divide to the bushings in the inboard bulkhead and to the branch box, along the runs determined in Step 6.

9. Spot and mark position on branch box where cable will penetrate.

10. Remove branch box, drill, tap and insert a terminal tube for DHFA-3 cable in the position determined in Step 9.

11. Reinstall the branch box.

12. Pull DHFA-3 cable through the outboard stuffing tube in the after bulkhead.

13. Prepare the end of the cable and insert it through the terminal tube into the branch box.

14. Pick up the DHFA-3 cable at the inboard bulkhead and pass it through the remaining stuffing tube in the after bulkhead.

15. Install one-eared cable straps over the cable from the branch box, and from the inboard bulkhead to the point where the two cables come together and secure to the pads.

16. Install two-eared cable straps from the meeting point of the cables to the after bulkhead.

17. Take up the slack cable, passing the excess cable through the stuffing tubes into the after compartment.

18. Tighten the cable straps.

19. Pack the stuffing tubes and the terminal tube.

20. Prepare the end of a DCP-4 cable and insert it through the terminal tube in the pear-type pushbutton.

21. Pack the terminal tube in the pushbutton.

22. Determine the length of DCP-4 cable required to let the pushbutton hang over a mess table. Cut off the excess.

23. Prepare free end of DCP-4 cable and insert it through the terminal tube in the cover of the branch box.

24. Pack the terminal tube in the cover of the branch box.

25. Install lugs and connect wires of cables in pushbutton and branch box as shown in the elementary wiring diagram of Drawing 3.

26. Assemble pushbutton and branch box.

JOB 3. Install pushbutton and associated cable in the Pilot House.

Procedure:

1. Drill, tap and insert a terminal tube for Type DHFA-3 cable in the "boss" of the pushbutton.

2. Select location, spot, center punch and have the deck drilled (at the outboard starboard side of the forward bulkhead) for a stuffing tube for DHFA-3 cable.

3. Install a stuffing tube and kickpipe in the hole in the deck.

4. Mount the pushbutton on the forward bulkhead directly above the stuffing tube.

5. Figure the run of the cable from the stuffing tube to the pushbutton.

6. Spot locations and have pads for one-eared straps welded to the forward bulkhead from the kickpipe to the pushbutton.

7. Pull DHFA-3 cable through the stuffing tube.

8. Prepare the end of the cable and insert through terminal tube into the pushbutton.

9. Install one-eared cable straps over the cable and secure to the pads.

10. Take up the slack cable, passing the excess cable through the stuffing tube into the compartment below.

11. Pack the stuffing tube and the terminal tube.

12. Tighten the cable straps.

13. Install lugs and connect section wires of the elementary wiring diagram of Drawing 3.

14. Assemble the pushbutton.

JOB 4. Install pushbutton and all associated system wiring in Wash Room and Water Closet.

Procedure:

1. Drill, tap and insert a terminal tube for Type DHFA-3 cable in the "boss" of the pushbutton.
2. Select horizontal adjacent locations, spot, center punch and have the forward end of the inboard bulkhead drilled for two stuffing tubes for DHFA-3 cable.
3. Install stuffing tubes in the drilled holes in the inboard bulkhead.
4. Mount the pushbutton on pads on the forward end of the inboard bulkhead.
5. Figure the run of the cable from the cable penetrating the overhead to the forward stuffing tube in the inboard bulkhead.
6. Figure the run of the cable from the pushbutton to the after stuffing tube in the inboard bulkhead.
7. Spot locations and have pads for one-eared cable straps welded to the overhead along the run figured in Step 5.
8. Spot locations and have pads for one-eared cable straps welded to the inboard bulkhead along the run figured in Step 6.
9. Pick up the cable at the overhead and pass through the forward stuffing tube in the inboard bulkhead.
10. Install one-eared cable straps over the cable on the overhead and secure to the pads.
11. Take up the slack cable, passing the excess cable through the stuffing tube into the adjacent compartment.
12. Pull DHFA-3 cable through the after stuffing tube in the inboard bulkhead.
13. Prepare the end of the cable (Step 12) and insert it through the terminal tube into the pushbutton.
14. Install one-eared cable straps over the cable on the inboard bulkhead and secure to the pads.
15. Take up the slack cable, passing the excess cable through the stuffing tube into the adjacent compartment.
16. Pack the stuffing tubes and the terminal tube.
17. Tighten the cable straps.
18. Install lugs and connect section wires of the DHFA-3 cable to the pushbutton as shown in the elementary wiring diagram of Drawing 3.
19. Assemble the pushbutton.

JOB 5. Install 6-drop annunciator, vibrating bell, 10-wire box and all associated system wiring in Pantry.

Procedure:

1. Nipple bell and annunciator together.

2. Mount annunciator on pads and bell on "U" straps on the outboard side of the forward bulkhead.

3. Mount 10-wire connection box on pads on the overhead (forward and inboard).

4. Select location, spot, center punch and have the inboard side of the after bulkhead drilled for a stuffing tube for DHFA-3 cable.

5. Install stuffing tube in after bulkhead (from Engine Room side).

6. Figure the run of the cable, on the overhead from the stuffing tube in the after bulkhead to the 10-wire box.

7. Figure the runs of the cables from the stuffing tubes in the inboard and forward bulkheads to 10-wire box.

8. Figure the run of the cable from the 10-wire box to the 9-drop annunciator.

9. Spot locations and have pads for one-eared cable straps welded to the overhead along the run figured in Step 6.

10. Spot locations and have pads for two-eared cable straps welded to the overhead along the runs figured in Step 7.

11. Spot locations and have pads for one-eared cable straps welded to the overhead and forward bulkhead along the run figured in Step 8.

12. Spot and mark positions on 10-wire connection box and 9-drop annunciator where cables will penetrate.

13. Remove the 10-wire connection box, drill, tap and insert terminal tubes for 5 DHFA-3 cables and one MHFA-7 cable, in the locations determined in Step 12.

14. Remount the 10-wire connection box.

15. Remove annunciator, drill, tap and insert a terminal tube for an MHFA-7 cable, in the location determined in Step 12.

16. Remount the annunciator.

17. Determine actual lengths of cable required for cables from forward and inboard bulkheads to enter the 10-wire connection box. Cut off excess cable.

18. Prepare ends of cables from forward and inboard bulkheads and insert through their respective terminal tubes into the 10-wire connection box.

19. Pull a DHFA-3 cable through the stuffing tube in the after bulkhead.

20. Prepare the end of the DHFA-3 cable and insert it through the terminal tube into the 10-wire connection box.

21. Install one-eared cable straps over the cable from the after bulkhead and secure to the pads.

22. Prepare the end of an MHFA-7 cable and insert through the terminal tube into the 10-wire connection box.

23. Install one-eared cable straps over the MHFA-7 cable and secure to the pads along the run to annunciator.

24. Take up the slack cable (Step 23) pushing the excess toward the annunciator.

25. Pack the terminal tubes in the 10-wire connection box.

26. Install two-eared straps over the cables from the forward and inboard bulkheads and secure to the pads.

27. Tighten the two-eared cable straps.

28. Take up the excess cable from the 10-wire connection box to the after bulkhead, passing the excess cable into the after compartment.

29. Tighten all one-eared cable straps on the overhead.

30. Determine actual length of cable required to complete run to annunciator. Cut off excess cable.

31. Prepare the end of the MHFA-7 cable and insert through the terminal tube into the annunciator.

32. Pack the terminal tube in the annunciator.

33. Install one-eared cable straps over the cable on the forward bulkhead and secure to the pads.

34. Tighten the cable straps (Step 33).

35. Install cable lugs and connect corresponding section wires in all cables to common studs in the 10-wire connection box.

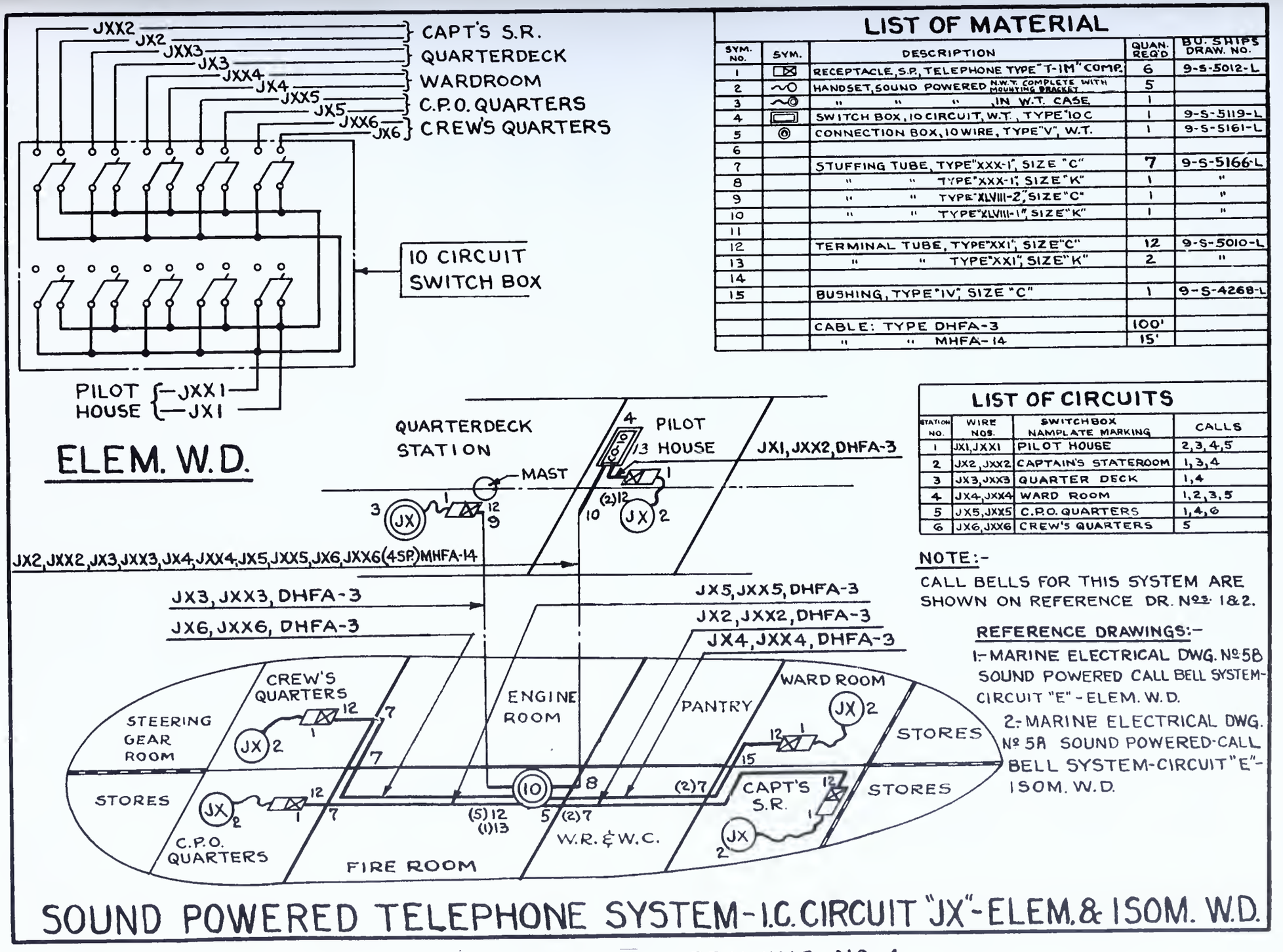
36. Install cable lugs and connect section wires of the MHFA-7 cable to the annunciator and bell as shown in the elementary wiring diagram of Drawing 3.

37. Assemble the annunciator and 10-wire connection box.

JOB 6. Install cable and connect to the Interior Communication Switchboard in the Engine Room.

Procedure:

1. Pack the stuffing tube in forward bulkhead.
2. Figure run of cable on the overhead and after bulkhead from the forward bulkhead to the I. C. switchboard.
3. Spot locations and have pads for one-eared cable straps welded to the overhead and after bulkhead, along the run determined in Step 1.
4. Install one-eared cable straps over the cable and secure to the pads.
5. Take up the slack cable, pushing the excess toward the switchboard.
6. Tighten the cable straps on the overhead.
7. Figure the actual amount of cable required to complete the run to the switchboard. Cut off the excess cable.
8. Prepare the cable end, install lugs and connect to a fused switch on the I. C. switchboard.
9. Install one-eared cable straps over the cable on the after bulkhead.
10. Tighten the cable straps.
11. Install 3-ampere fuses at the switch on the I. C. switchboard.
12. Test the entire system.



LIST OF MATERIAL

SYM. NO.	SYM.	DESCRIPTION	QUAN. REQ'D	BU. SHIPS DRAW. NO.
1		RECEPTACLE, S.P., TELEPHONE TYPE "T-1M" COMP.	6	9-S-5012-L
2		HANDSET, SOUND POWERED N.W.T. COMPLETE WITH MOUNTING BRACKET	5	
3		" " " " IN W.T. CASE	1	
4		SWITCH BOX, 10 CIRCUIT, W.T., TYPE "10C	1	9-S-5119-L
5		CONNECTION BOX, 10 WIRE, TYPE "V", W.T.	1	9-S-5161-L
6				
7		STUFFING TUBE, TYPE "XXX-1", SIZE "C"	7	9-S-5166-L
8		" " TYPE "XXX-1", SIZE "K"	1	"
9		" " TYPE "XLVIII-2", SIZE "C"	1	"
10		" " TYPE "XLVIII-1", SIZE "K"	1	"
11				
12		TERMINAL TUBE, TYPE "XX1", SIZE "C"	12	9-S-5010-L
13		" " TYPE "XX1", SIZE "K"	2	"
14				
15		BUSHING, TYPE "IV", SIZE "C"	1	9-S-4268-L
		CABLE: TYPE DHFA-3	100'	
		" " MHFA-14	15'	

LIST OF CIRCUITS

STATION NO.	WIRE NOS.	SWITCHBOX NAMPLATE MARKING	CALLS
1	JX1, JXX1	PILOT HOUSE	2, 3, 4, 5
2	JX2, JXX2	CAPTAIN'S STATEROOM	1, 3, 4
3	JX3, JXX3	QUARTER DECK	1, 4
4	JX4, JXX4	WARD ROOM	1, 2, 3, 5
5	JX5, JXX5	C.P.O. QUARTERS	1, 4, 6
6	JX6, JXX6	CREW'S QUARTERS	5

NOTE:-

CALL BELLS FOR THIS SYSTEM ARE SHOWN ON REFERENCE DR. Nos. 1 & 2.

REFERENCE DRAWINGS:-

1.- MARINE ELECTRICAL DWG. No. 5B SOUND POWERED CALL BELL SYSTEM-CIRCUIT "E" - ELEM. W.D.

2.- MARINE ELECTRICAL DWG. No. 5A SOUND POWERED-CALL BELL SYSTEM-CIRCUIT "E"- ISOM. W.D.

SOUND POWERED TELEPHONE SYSTEM - I.C. CIRCUIT "JX" - ELEM. & ISOM. W.D.

MARINE ELECTRICAL DRAWING No. 4

SOUND POWERED TELEPHONE SYSTEM - I.C. CIRCUIT "JX"

MARINE ELECTRICAL DRAWING NO. 4

List of Jobs

Note: Actual cable lengths may be determined by trainees doing individual jobs or by trainees doing Job 9, at the discretion of the instructor.

JOB 1. Install a sound powered telephone handset, mounting bracket receptacle and associated wiring in the Wardroom.

Procedure:

1. Locate, center punch and have a hole drilled in the after end of the inboard bulkhead for a bushing for Type DHFA-3 cable.
2. Install a bushing in the hole in the inboard bulkhead.
3. Spot location and install receptacle on pads on the after bulkhead, midway between the inboard and outboard bulkheads.
4. Spot location and install the handset mounting bracket on pads on the after bulkhead, above the receptacle.
5. Figure the run of the cable from the bushing in the inboard bulkhead to the receptacle.
6. Spot locations and have pads for one-eared cable straps welded to the bulkhead along the run determined in Step 5.
7. Spot and mark positions on the side of the receptacle where cable will penetrate.
8. Remove the receptacle, drill, tap and insert a terminal tube for DHFA-3 cable, in the location determined in Step 7.
9. Drill, tap and insert terminal tube for DCP-2 cable, in bottom of receptacle.
10. Remount the receptacle on the pads.
11. Pull DHFA-3 cable through the bushing in the inboard bulkhead, starting in the adjacent compartment.
12. Prepare the end of the DHFA-3 cable and insert it through the terminal tube (Step 8) into the receptacle.

13. Install one-eared straps over the DHFA-3 cable and secure loosely to the pads.

14. Pack the terminal tube (Step 8).

15. Take up the slack DHFA-3 cable, passing the excess cable through the bushing into the adjacent compartment.

16. Tighten the cable straps.

17. Prepare the end of the flexible cable on the handset and insert through the wire coil guard and the terminal tube (Step 9) into the receptacle.

    Note: Sound powered telephone handsets are supplied with a length of flexible cable installed.

18. Pack the terminal tube (Step 9).

19. Install lugs and connect wires of cable to the receptacle studs.

20. Assemble the receptacle.

21. Mount the handset on the mounting hook.

JOB 2. Install a sound powered hand set, mounting bracket, receptacle and associated wiring in captain's stateroom.

Procedure:

1. Select horizontal adjacent locations, spot, center punch and have the inboard side of the after bulkhead drilled for two stuffing tubes for DHFA-3 cables.

2. Install stuffing tubes in the holes in the after bulkhead, starting from the after compartment.

3. Spot location and install the receptacle on pads on the forward end of the inboard bulkhead.

4. Spot location and install handset mounting bracket on pads on the inboard bulkhead, above the receptacle.

5. Figure the run of the cable from the inboard stuffing tube in the after bulkhead to the bushing in the inboard bulkhead.

6. Figure the run of cable from the outboard stuffing tube in the after bulkhead to the side of the receptacle.

7. Spot locations and have pads for one-eared cable straps welded to the inboard bulkhead along the run figured in Step 6.

8. Spot locations and have pads for two-eared cable straps welded to the after bulkhead along the run figured in Steps 5 and 6.

9. Remove receptacle, drill, tap and insert a terminal tube for Type DHFA-3 cable in the side of the receptacle.

10. Drill, tap and insert terminal tube for DCP-2 cable, in the bottom of the receptacle.

11. Pick up the DHFA-3 cable at the inboard bulkhead and pass through the inboard stuffing tube in the after bulkhead.

12. Pull a DHFA-3 cable through the outboard stuffing tube in the after bulkhead, starting from the after compartment.

13. Prepare the end of the cable (Step 12) and insert it through the terminal tube (Step 9) into the receptacle.

14. Install one-eared cable straps over the cable from the receptacle to the after bulkhead and secure loosely to the pads.

15. Install two-eared cable straps over both cables and secure loosely to pads on the after bulkhead.

16. Pack the terminal tube in the side of the receptacle.

17. Take up the slack cable, passing the excess cable through the stuffing tubes into the after compartment.

18. Pack the stuffing tubes.

19. Tighten the one-eared and two-eared cable straps.

20. Prepare the end of the flexible cable on the handset and insert through the wire coil guard and terminal tube into the receptacle.

    Note: Sound powered telephone handsets are supplied with a length of flexible cable installed.

21. Pack the terminal tube (Step 10).

22. Install lugs and connect the wires of the cables to the receptacle studs.

23. Assemble the receptacle.

24. Mount the handset on the mounting bracket.

JOB 3. Install a 10-circuit switch box, sound powered telephone handset, mounting bracket, receptacle and associated wiring in the Pilot House.

Procedure:

1. Select adjacent locations and mount 10-circuit switch box and receptacle on pads on the starboard side of the after bulkhead.

2. Spot location and install handset mounting bracket on pads on the after bulkhead, above the receptacle.

3. Select location, spot, center punch and have deck drilled for a stuffing tube for MHFA-14 cable.

4. Install a stuffing tube and kick pipe in the hole in the deck.

5. Figure the runs of cable from the stuffing tube to the 10-circuit switch box and from the 10-circuit switch box to the side of the receptacle.

6. Spot locations and have pads for one-eared cable straps welded to the after bulkhead, along the runs figured in Step 5.

7. Spot and mark positions on 10-circuit switch box and the receptacle where cables will penetrate.

8. Remove 10-circuit switch box and drill, tap and insert one terminal tube for an MHFA-14 cable and one terminal tube for a DHFA-3 cable, in the locations determined in Step 7.

9. Remove the receptacle, drill, tap and insert a terminal tube for a DHFA-3 cable, in the location determined in Step 7.

10. Drill, tap and insert a terminal tube for a DCP-3 cable in the bottom of the receptacle.

11. Remount the circuit switch box and the receptacle.

12. Prepare the end of a DHFA-3 cable and insert it through the proper terminal tube into the 10-circuit switch box.

13. Install one-eared straps over the DHFA-3 cable from the 10-circuit switch box to the receptacle and secure loosely to the pads.

14. Determine the actual length required to complete the cable run to the receptacle. Cut off the excess cable.

15. Prepare the end of the DHFA-3 cable and insert it through the terminal tube (Step 9) into the receptacle.

16. Pull an MHFA-14 cable through the stuffing tube and kick-pipe in the deck, starting from the compartment below.

17. Prepare the end of the MHFA-14 cable and insert it through the terminal tube into the 10-circuit switch box.

18. Install one-eared cable straps over the MHFA-14 cable and secure loosely to the pads.

19. Pack the terminal tubes (Steps 8 and 9).

20. Take up the slack MHFA-14 cable, passing the excess into the compartment below.

21. Tighten the cable straps.

22. Prepare the end of the flexible cable on the handset and insert through the wire coil guard and terminal tube into the receptacle.

    Note: Sound powered telephone handsets are supplied with a length of flexible cable installed.

23. Pack the stuffing tube.

24. Install lugs and connect wires of the cable to the receptacle studs and to the switches in the 10-circuit switch box as shown on the elementary wiring diagram of Drawing 4.

25. Assemble the receptacle and 10-circuit switch box.

26. Mount the handset on the mounting hook.

JOB 4. Install wiring system in the Wash Room and Water Closet.

Procedure:

1. Select horizontal adjacent locations, spot, center punch and have the inboard side of the after bulkhead drilled for stuffing tubes for two DHFA-3 and one MHFA-14 cables.

2. Install stuffing tubes in the drilled holes in the after bulkhead.

3. Figure the run of cables (side by side) on the overhead from the stuffing tubes in the forward bulkhead to the stuffing tubes in the after bulkhead.

4. Spot locations and have pads for two-eared cable straps welded to the overhead along the run figured in Step 3.

5. Figure the run of cable from the stuffing tube in the overhead to the stuffing tube in the after bulkhead.

6. Spot locations and have pads for one-eared cable straps welded to the overhead and the after bulkhead along the run figured in Step 5.

7. Pick up the two DHFA-3 cables at the forward bulkhead and pass through the stuffing tubes in the after bulkhead.

8. Install two-eared cable straps over the two DHFA-3 cables and secure loosely to the pads.

9. Pick up the MHFA-14 cable at the overhead and pass through the stuffing tube in the after bulkhead.

10. Install one-eared cable straps over the MHFA-14 cable and secure loosely to the pads.

11. Take up the slack cable in each run, passing the excess cable through the stuffing tubes into the after compartment.

12. Pack all the stuffing tubes.

13. Tighten all cable straps.

JOB 5. Install a sound powered telephone handset, mounting bracket, receptacle and associated wiring in the Crew's Quarters.

Procedure:

1. Locate, center punch and have a hole drilled in the forward bulkhead for a stuffing tube for a Type DHFA-3 cable, midway between the inboard and outboard bulkhead.

2. Install a stuffing tube in the hole in the forward bulkhead, starting in the forward compartment.

3. Spot location and install receptacle on pads on the forward bulkhead, midway between the inboard and outboard bulkheads.

4. Spot location and install the handset mounting bracket on pads on the forward bulkhead above the receptacle.

5. Figure the run of the cable from the stuffing tube in the forward bulkhead to the side of the receptacle.

6. Spot locations and have pads for one-eared cable straps welded to the bulkhead along the run determined in Step 5.

7. Remove receptacle, drill, tap and insert terminal tube for DHFA-3 cable in the side of the receptacle.

8. Drill, tap and insert terminal tube for DCP-2 cable, in bottom of receptacle.

9. Remount the receptacle on the pads.

10. Pull a DHFA-3 cable through the stuffing tube in the forward bulkhead, starting in the forward compartment.

11. Prepare the end of the cable and insert through the terminal tube (Step 7) into the receptacle.

12. Install one-eared straps over the cable and secure loosely to the pads.

13. Pack the terminal tube (Step 7).

14. Take up the slack cable, passing the excess cable through the tube into the adjacent compartment.

15. Tighten the cable straps.

16. Pack the stuffing tube.

17. Prepare the end of the flexible cable on the handset and insert through the wire coil guard and the terminal into the receptacle.

    Note: Sound powered telephone handsets are supplied with a length of flexible cable installed.

18. Pack the terminal tube (Step 8).

19. Install lugs and connect wires of cable to the receptacle studs.

20. Assemble the receptacle.

21. Mount the handset on the mounting bracket.

JOB 6. Install a sound powered telephone handset, mounting bracket and associated wiring in C.P.O. Quarters.

Procedure:

1. Locate, center punch and have a hole drilled in the forward bulkhead for a stuffing tube for a Type DHFA-3 cable, adjacent to the inboard bulkhead.

2. Install a stuffing tube in the hole in the forward bulkhead, starting in the forward compartment.

3. Spot location and install the receptacle on pads on the forward bulkhead, midway between the inboard and outboard bulkheads.

4. Spot location and install the handset mounting bracket on pads on the forward bulkhead above the receptacle.

5. Figure the run of the cable from the stuffing tube in the forward bulkhead to the side of the receptacle.

6. Spot locations and have pads for one-eared cable straps welded to the bulkhead, along the run determined in Step 5.

7. Remove receptacle, drill, tap and insert terminal tube for DHFA-3 cable, in the side of the receptacle.

8. Drill, tap and insert terminal tube for DCP-2 cable, in the bottom of the receptacle.

9. Remount the receptacle on the pads.

10. Pull a DHFA-3 cable through the stuffing tube, starting from the forward compartment.

11. Prepare the end of the DHFA-3 cable and insert through the terminal tube (Step 7) into the receptacle.

12. Install one-eared straps over the cable and secure loosely to the pads.

13. Pack the terminal tube (Step 7).

14. Take up the slack cable, passing the excess cable through the stuffing tube into the forward compartment.

15. Tighten the cable straps.

16. Pack the stuffing tube.

17. Prepare the end of the flexible cable on the handset and insert through the wire coil guard and the terminal tube (Step 8) into the receptacle.

    Note: Sound powered telephone handsets are supplied with a length of flexible cable installed.

18. Pack the terminal tube (Step 8).

19. Install lugs and connect wires of cable to the receptacle studs.

20. Assemble the receptacle.

21. Mount the handset on the mounting bracket.

JOB 7. Install sound powered handset in watertight case, receptacle and associated wiring at the Quarterdeck Station.

Procedure:

1. Nipple receptacle to watertight case for handset (receptacle below the watertight case).

2. Drill, tap and insert a terminal tube for a DHFA-3 cable, in the bottom of the receptacle.

3. Spot location and install the receptacle and watertight case assembly (Step 1) on brackets on the mast.

4. Select location, spot, center punch and have the deck drilled for a stuffing tube for a DHFA-3 cable.

5. Install a stuffing tube and kickpipe in the hole in the deck.

6. Figure the run of the cable from the kickpipe in the deck to the terminal tube in the receptacle.

7. Spot locations and have pads for one-eared cable straps welded to the mast, along the run figured in Step 6.

8. Pull a DHFA-3 cable through the stuffing tube and the kickpipe, starting from the compartment below.

9. Prepare the end of the DHFA-3 cable and insert through the terminal tube into the receptacle.

10. Install one-eared cable straps over the cable and secure loosely to the pads.

11. Pack the terminal tube in the receptacle.

12. Take up the slack cable passing the excess cable through the stuffing tube into the compartment below.

13. Pack the stuffing tube.

14. Tighten the cable straps.

15. Prepare the end of the flexible cable on the handset and insert through the nipple in the W.T. case into the receptacle.

    Note: Sound powered telephone handsets are supplied with a length of flexible cable installed.

16. Install lugs and connect the wires of the cable to the receptacle studs.

17. Assemble the receptacle.

18. Mount the handset on the mounting bracket in the watertight case.

JOB 8. Install wiring system in the Engine Room.

Procedure:

1. Select location, spot, center punch and have the after end of the inboard bulkhead drilled for a stuffing tube for a DHFA-3 cable.

2. Install a stuffing tube in the hole in the inboard bulkhead.

3. Figure the run of the cable along the after and inboard bulkheads from the stuffing tube in the after bulkhead to the stuffing tube in the inboard bulkhead.

4. Spot locations and have pads for one-eared cable straps welded to the after and inboard bulkheads along the run figured in Step 3.

5. Pick up the cable at the after bulkhead and pass through the stuffing tube in the inboard bulkhead.

6. Install one-eared cable straps over the cable and secure loosely to the pads.

7. Take up the slack cable, passing the excess into the Fire Room.

8. Pack the stuffing tube in the inboard bulkhead.

9. Tighten the cable straps.

JOB 9. Install 10-wire connection box and associated system wiring in the Fire Room.

Procedure:

1. Select location and mount the 10-wire connection box on pads on the inboard bulkhead.

2. Figure the run of the cable along the after bulkhead from the stuffing tube in the after bulkhead to the inboard bulkhead.

3. Figure the run of the cable (Step 2) together with the cable from the stuffing tube in the inboard bulkhead to the 10-wire connection box. Figure the run of the cables on the inboard bulkhead.

4. Figure the run of the three cables from the forward bulkhead to the 10-wire connection box along the forward and inboard bulkheads.

5. Figure the run of the cable from the overhead to the 10-wire connection box.

6. Spot locations and have pads for one-eared cable straps welded to the ship's structure along the runs figured in Steps 2 and 5.

7. Spot locations and have pads for two-eared cable straps welded to the ship's structure along the runs figured in Steps 3 and 4.

8. Spot and mark positions on the 10-wire connection box where cables will penetrate.

9. Remove the 10-wire connection box, drill, tap and insert terminal tubes for 5 DHFA-3 cables and one MHFA-14 cable, in the locations determined in Step 8.

10. Remount the 10-wire connection box on the pads.

11. Determine the actual lengths of cable required for all cables to enter the 10-wire connection box. Cut off the excess cable.

12. Prepare the ends of all cables and insert through their respective terminal tubes into the 10-wire connection box.

13. Install one-eared straps over the cable from the stuffing tube in the after bulkhead to the inboard bulkhead and over the cable from the stuffing tube in the overhead to the 10-wire connection box and secure to the pads.

14. Install two-eared straps over the cables on the inboard bulkhead from the after bulkhead to the 10-wire connection box and secure to the pads.

15. Install two-eared straps over the cables from the stuffing tubes in the forward bulkhead to the 10-wire connection box and secure to the pads.

16. Pack the terminal tubes in the 10-wire connection box.

17. Tighten the cable straps.

18. Install cable lugs and connect corresponding section wires in all cables to common studs in the 10-wire connection box.

19. Assemble the 10-wire connection box.

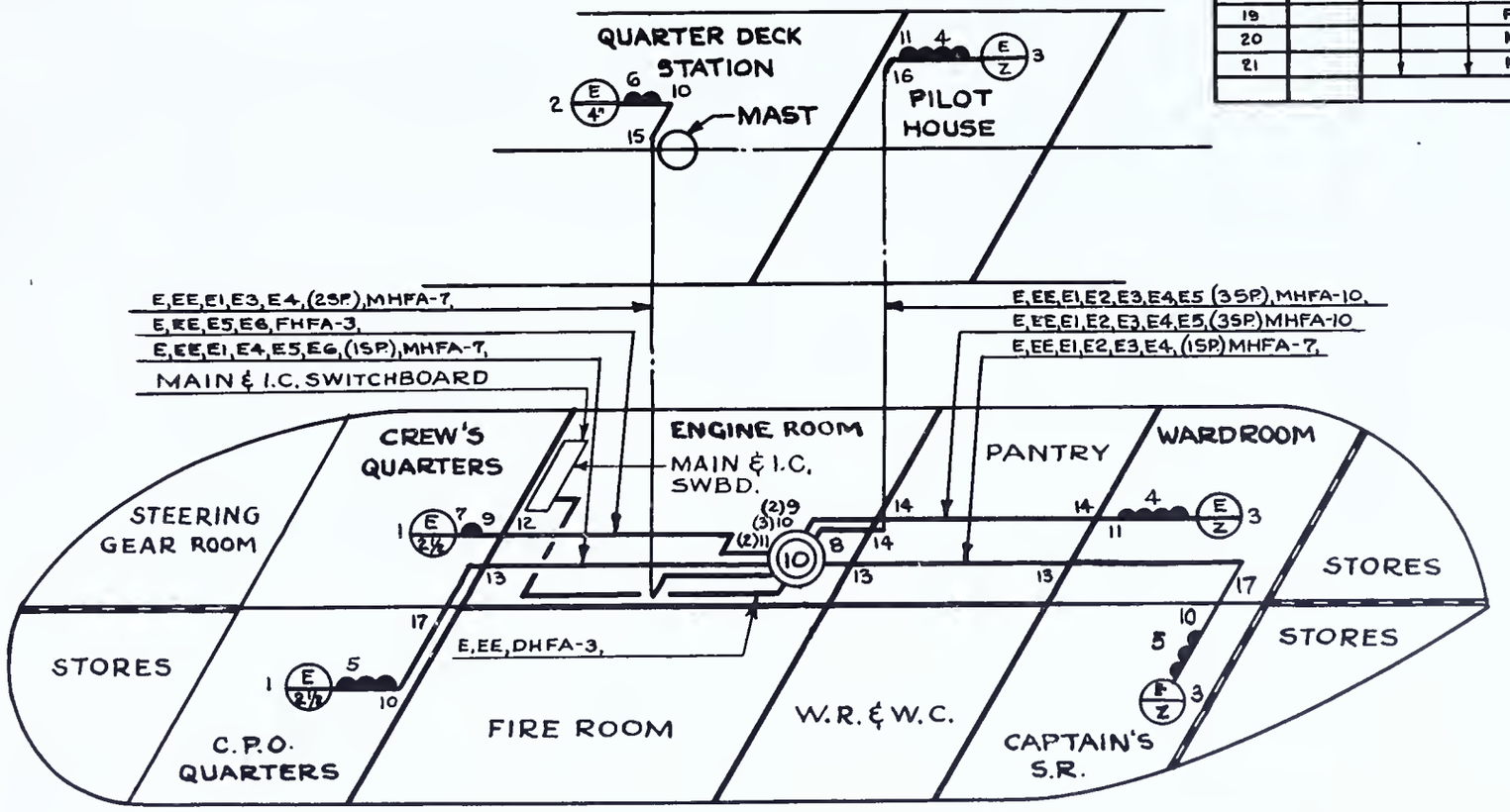
20. Test the circuit.

REFERENCE DRAWINGS

1. MARINE ELECTRICAL DRAWING Nº 4 — SOUND POWERED TELEPHONE SYSTEM, CIRCUIT "JX", ELEM. & ISOM. WIRING DIAGRAM.
2. MARINE ELECTRICAL DRAWING Nº 5B - SOUND POWERED TELEPHONE CALL BELL SYSTEM, I.C. CIRCUIT "E", ELEM. WIRING DIAGRAM.

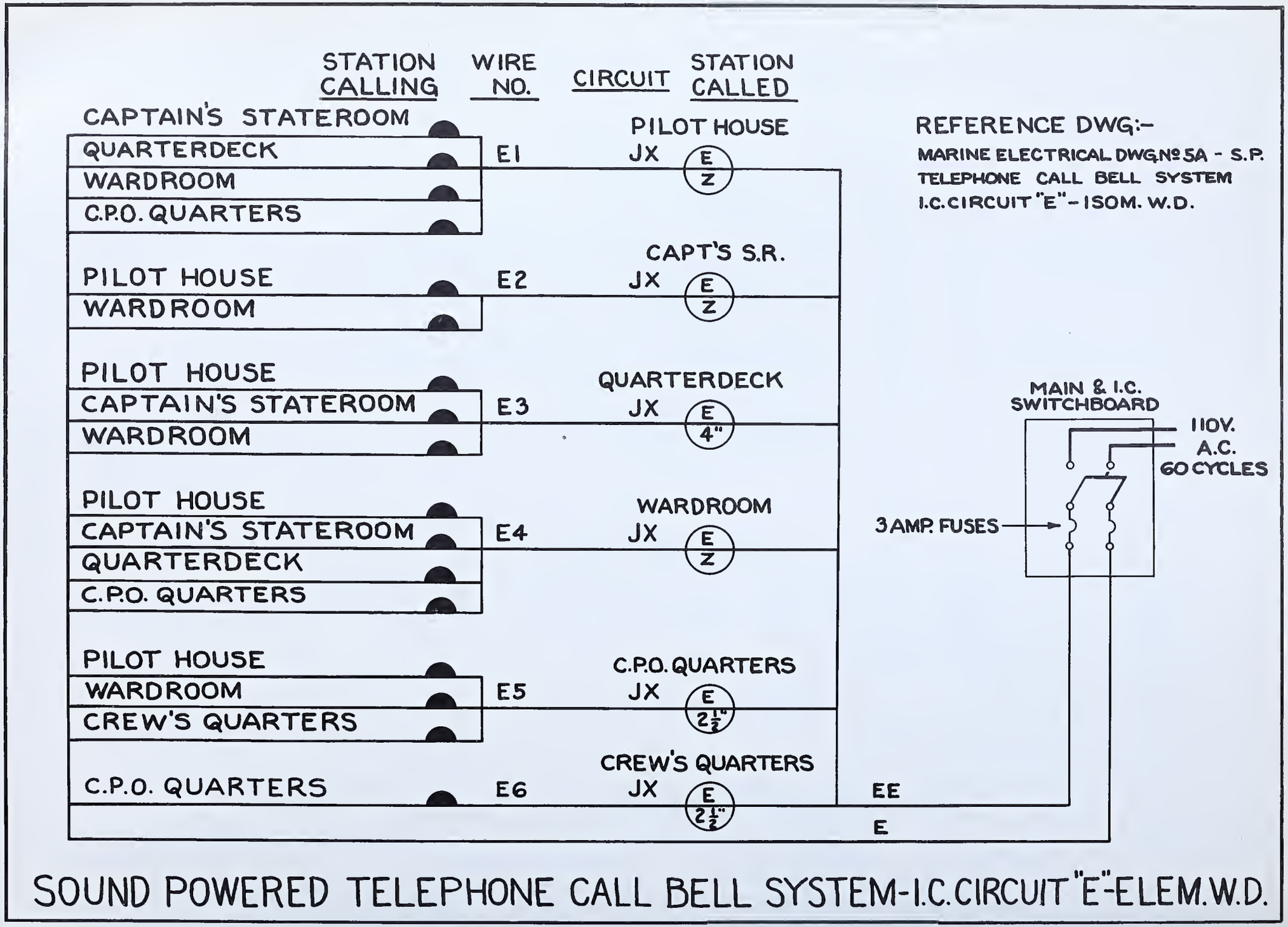
LIST OF MATERIAL

SYM NO.	SYM.	DESCRIPTION	QUAN. REQ'D.	DRAW. NO.
1	⊖	BELL, 2½", VIBRATING, 110V., 60~, A.C., W.T.	2	
2	⊖	4"	1	
3	⊖	BUZZER, LOW PITCH, LOW INTENSITY, 110V. A.C. 60~, W.T.	3	
4	▬	PUSHBUTTON, 4 GANG, TYPE "A", W.T.	2	9-S-4490-L
3	▬	3	2	9-S-4489-L
6	▬	2	1	9-S-4488-L
7	▬	SINGLE "R"	1	9-S-4581-L
8	ⓒ	CONNECTION BOX, 10 WIRE, TYPE "V", W.T.	1	9-S-5161-L
9		TERMINAL TUBE, TYPE "XXI", SIZE "C"	3	9-S-5010-L
10		"G"	6	
11		"K"	4	
12		STUFFING TUBE, TYPE "XXX-1", SIZE "C"	1	9-S-5166-L
13		"G"	3	
14		"K"	3	
15		"XLVIII-2" "G"	1	
16		"XLVIII-1" "K"	1	
17		BUSHING, TYPE "IV", SIZE "G"	2	9-S-4268-L
18		CABLE, TYPE DHFA-3	20'	
19		FHFA-3	15'	
20		MHFA-7	65'	
21		MHFA-10	30'	



SOUND POWERED TELEPHONE CALL BELL SYSTEM - I.C. CIRCUIT "E" - ISOMETRIC W.D.

MARINE ELECTRICAL DRAWING Nº 5A



SOUND POWERED TELEPHONE CALL BELL SYSTEM-I.C. CIRCUIT "E"-ELEM. W.D.

MARINE ELECTRICAL DRAWING Nº 5B

SOUND POWERED TELEPHONE CALL BELL SYSTEM - CIRCUIT "E"

MARINE ELECTRICAL DRAWINGS 5-A and 5-B

List of Jobs

Note: Actual cable lengths may be determined by trainees in each job or by those doing Job 8 at the discretion of the instructor.

JOB 1. Install buzzer, 3 gang pushbutton and associated wiring in Captain's Stateroom.

Procedure:

1. Nipple the buzzer and the 3 gang pushbutton together.
2. Drill, tap and insert a terminal tube for Type MHFA-7 cable in the end of the 3 gang pushbutton.
3. Select location, spot, center punch and have the forward end of the inboard bulkhead drilled for a bushing for MHFA-7 cable.
4. Install a bushing in the hole in the inboard bulkhead.
5. Spot location and install the buzzer and pushbutton assembly on pads on the forward end of the inboard bulkhead.
6. Figure the run of cable from the bushing in the inboard bulkhead to the terminal tube in the buzzer and pushbutton assembly (Step 2).
7. Spot locations and have pads for one-eared cable straps welded to the bulkhead, along the run determined in Step 6.
8. Pull an MHFA-7 cable through the bushing in the inboard bulkhead, starting in the adjacent compartment.
9. Prepare the end of the cable and insert through the terminal tube (Step 2) into the pushbutton and buzzer assembly.
10. Install one-eared straps over the cable and secure loosely to the pads.
11. Pack the terminal tube (Step 2).
12. Take up the slack cable, passing the excess cable through the bushing into the adjacent compartment.
13. Tighten the cable straps.
14. Install lugs and connect wires of the cable to the pushbuttons and buzzer as shown on Drawing 5-B.
15. Assemble the pushbuttons and the buzzer.

JOB 2. Install buzzer, 4 gang pushbutton and associated wiring in the Wardroom.

Procedure:

1. Nipple the buzzer and the 4 gang pushbutton together.

2. Drill, tap and insert a terminal tube for Type MHFA-10 cable in the end of the 4 gang pushbutton.

3. Select horizontal adjacent locations, spot, center punch and have the inboard side of the after bulkhead drilled for one stuffing tube for MHFA-10 cable and one stuffing tube for MHFA-7 cable, the stuffing tube for MHFA-10 cable to take the outboard position.

4. Install stuffing tubes in the holes in the after bulkhead, starting from the after compartment.

5. Spot location and install the buzzer and pushbutton assembly on pads on the after bulkhead, midway between the inboard and outboard bulkheads.

6. Figure the run of the MHFA-10 cable from the stuffing tube in the after bulkhead to the buzzer and pushbutton assembly.

7. Figure the run of cable from the inboard stuffing tube in the after bulkhead to the bushing in the inboard bulkhead, along the after and inboard bulkhead

8. Spot locations and have pads for one-eared cable straps welded to the bulkhead, along the runs figured in Steps 6 and 7.

9. Pick up the MHFA-7 cable at the inboard bulkhead and pass through the inboard stuffing tube in the after bulkhead.

10. Pull an MHFA-10 cable through the outboard stuffing tube in the after bulkhead, starting from the after compartment.

11. Prepare the end of the cable (Step 10) and insert through the terminal tube into the pushbutton and buzzer assembly.

12. Install one-eared cable straps over the cable from the inboard bulkhead to the after bulkhead and secure loosely to the pads.

13. Install one-eared cable straps over the cable from the pushbutton and buzzer assembly and secure loosely to the pads.

14. Take up the slack cable, passing the excess cable through the stuffing tubes into the after compartment.

15. Pack the terminal tube.

16. Tighten all cable straps.

17. Pack the stuffing tubes.

18. Install lugs and connect the wires of the MHFA-10 cable to the pushbuttons and the buzzer, as shown on Drawing 5-B.

19. Assemble the pushbuttons and the buzzer.

JOB 3. Install buzzer, 4 gang pushbutton and associated wiring in the Pilot House.

Procedure:

1. Nipple the buzzer and the 4 gang pushbutton together.
2. Drill, tap and insert a terminal tube for Type MHFA-10 cable in the end of the 4 gang pushbutton.
3. Select location and install the buzzer and pushbutton assembly on pads on the port side of the center line on the after bulkhead.
4. Select location, spot, center punch and have deck drilled for a stuffing tube for MHFA-10 cable.
5. Install a stuffing tube and kick pipe in the hole in the deck.
6. Figure the run of the cable from the stuffing tube to the pushbutton and buzzer assembly.
7. Spot locations and have pads for one-eared cable straps welded to the after bulkhead, along the run figured in Step 6.
8. Pull an MHFA-10 cable through the stuffing tube and kick pipe in the deck, starting from the compartment below.
9. Prepare the end of the cable and insert through the terminal tube into the pushbutton and buzzer assembly.
10. Install one-eared straps over the cable and secure loosely to the pads.
11. Pack the terminal tube.
12. Take up the slack cable, passing the excess into the compartment below.
13. Pack the stuffing tube.
14. Tighten the cable straps.
15. Install lugs and connect the wires of the cable to the pushbuttons and buzzer as shown on Drawing 5-B.
16. Assemble the pushbuttons and the buzzer.

JOB 4. Install wiring system in the Pantry.

Procedure:

1. Select horizontal adjacent locations, spot, center punch and have the inboard side of the after bulkhead drilled for two stuffing tubes for MHFA-10 cable and one stuffing tube for MHFA-7 cable. The stuffing tube for the MHFA-7 cable to take the inboard position.

2. Install stuffing tubes in the holes in the after bulkhead, starting from the after compartment.

3. Figure the run of cables (side by side) on the overhead from the stuffing tubes in the forward bulkhead to the stuffing tubes in the after bulkhead.

4. Spot locations and have pads for two-eared cable straps welded to the overhead along the run figured in Step 3.

5. Figure the run of cable from the stuffing tube in the overhead to the stuffing tube in the after bulkhead.

6. Spot locations and have pads for one-eared cable straps welded to the overhead and the after bulkhead along the run figured in Step 5.

7. Pick up the MHFA-7 and MHFA-10 cables at the forward bulkhead and pass through the stuffing tubes in the after bulkhead.

8. Install two-eared cables straps over the cables (Step 7) and secure loosely to the pads.

9. Pick up the MHFA-10 cable at the overhead and pass through the stuffing tube in the after bulkhead.

10. Install one-eared cable straps over the MHFA-10 cable (Step 9) and secure loosely to the pads.

11. Take up the slack cable in each run, passing the excess cable through the stuffing tubes into the after compartment.

12. Tighten all the cable straps.

13. Pack all the stuffing tubes.

JOB 5. Install bell, 3 gang pushbutton and associated wiring in C.P.O. Quarters.

Procedure:

1. Nipple the bell and the 3 gang pushbutton together.

2. Drill, tap and insert a terminal tube for Type MHFA-7 cable in the end of the 3 gang pushbutton.

3. Select location, spot, center punch and have the forward end of the inboard bulkhead drilled for a bushing for MHFA-7 cable.

4. Install a bushing in the hole in the inboard bulkhead.

5. Spot location and install the pushbutton and bell assembly on pads on the forward bulkhead, midway between the inboard and outboard bulkheads.

6. Figure the run of cable from the bushing in the inboard bulkhead to the terminal tube in the pushbutton and bell assembly (Step 2).

7. Spot locations and have pads for one-eared cable straps welded to the bulkhead, along the run determined in Step 6.

8. Pull an MHFA-7 cable through the bushing in the inboard bulkhead, starting in the adjacent compartment.

9. Prepare the end of the cable and insert through the terminal tube (Step 2) into the pushbutton and bell assembly.

10. Install one-eared straps over the cable and secure loosely to the pads.

11. Pack the terminal tube (Step 2).

12. Take up the slack cable, passing the excess cable through the bushing into the adjacent compartment.

13. Tighten the cable straps.

14. Install lugs and connect wires of the cable to the pushbutton and bell as shown on Drawing 5-B.

15. Assemble the pushbutton and the bell.

JOB 6. Install bell, single pushbutton and associated wiring in the Crew's Quarters.

Procedure:

1. Nipple the bell and the single pushbutton together.

2. Drill, tap and insert a terminal tube for Type MHFA-3 cable in the end of the pushbutton.

3. Select horizontal adjacent locations, spot, center punch and have the inboard side of the forward bulkhead drilled for one stuffing tube for MHFA-7 cable and one stuffing tube for FHFA-3 cable, the stuffing tube for the MHFA-7 cable to take the inboard position.

4. Install stuffing tubes in the holes in the forward bulkhead, starting from the forward compartment.

5. Spot location and install the pushbutton and bell assembly on pads on the forward bulkhead, midway between the inboard and outboard bulkheads.

6. Figure the run of the FHFA-3 cable from the stuffing tube in the forward bulkhead to the pushbutton and bell assembly.

7. Figure the run of cable from the bushing in the inboard bulkhead to the inboard stuffing tube in the forward bulkhead, along the after and inboard bulkheads.

8. Spot locations and have pads for one-eared cable straps welded to the bulkhead, along the runs figured in Steps 6 and 7.

9. Pick up the MHFA-7 cable at the inboard bulkhead and pass it through the inboard stuffing tube in the forward bulkhead.

10. Pull an FHFA-3 cable through the outboard stuffing tube in the forward bulkhead, starting from the forward compartment.

11. Prepare the end of the cable (Step 10) and insert through the terminal tube into the pushbutton and bell assembly.

12. Install one-eared straps over the cable from the inboard bulkhead to the forward bulkhead and secure loosely to the pads.

13. Install one-eared cable straps over the cable from the pushbutton and bell assembly and secure loosely to the pads.

14. Take up the slack cable, passing the excess cable through the stuffing tubes into the forward compartment.

15. Pack the terminal tube.

16. Tighten all cable straps.

17. Pack the stuffing tubes.

18. Install lugs and connect the wires of the FHFA-3 cable to the pushbutton and bell as shown on Drawing 5-B.

19. Assemble the pushbutton and bell.

JOB 7. Install bell, 2 gang pushbutton and associated wiring on the mast at the Quarterdeck Station.

Procedure:

1. Nipple the bell and the 2 gang pushbutton together.
2. Drill, tap and insert a terminal tube for Type MHFA-7 cable in the end of the 2 gang pushbutton.
3. Select location at the base of the mast, spot, center punch and have the deck drilled for a stuffing tube for an MHFA-7 cable.
4. Install a stuffing tube and kick pipe in the hole in the deck.
5. Spot location and install the pushbutton and bell assembly on a "U" bracket on the mast.
6. Figure the run of the cable from the pushbutton and bell assembly to the stuffing tube in the deck.
7. Spot locations and have pads for one-eared cable straps welded to the mast, along the run figured in Step 6.
8. Pull an MHFA-7 cable through the stuffing tube and the kick pipe, starting from the compartment below.
9. Prepare the end of the cable and insert through the terminal tube into the pushbutton and bell assembly.
10. Install one-eared straps over the cable and secure loosely to the pads.
11. Take up the slack cable, passing the excess cable through the stuffing tube into the compartment below.
12. Pack the terminal tube.
13. Tighten the cable straps.
14. Install lugs and connect the wires of the MHFA-7 cable to the pushbuttons and the bell, as shown on Drawing 5-B.
15. Assemble the pushbuttons and the buzzer.

JOB 8. Install a 10-wire connection box and associated system wiring in the Engine Room.

Procedure:

1. Select location and mount the 10-wire connection box on pads on the forward bulkhead.

2. Figure the run of the cables (side by side) from the stuffing tubes in the after bulkhead to the 10-wire connection box, along the after and inboard bulkheads.

3. Figure the run of Type DHFA-3 cable from the switchboard to the 10-wire connection box, following the run of cable determined in Step 2.

4. Figure the run of the MHFA-7 cable from the overhead to the 10-wire connection box, following the run of cable determined in Steps 2 and 3.

5. Figure the run of the cables (side by side) from the stuffing tubes in the forward bulkhead to the 10-wire connection box.

6. Spot locations and have pads for one-eared cable straps welded to the after bulkhead between the switchboard and the junction point of the MHFA-7 cable and the FHFA-3 cable.

7. Install a suitable wireway along the inboard and forward bulkheads.

8. Spot locations and have pads for two-eared cable straps welded to the forward bulkhead between the point where cables penetrate the forward bulkhead and the 10-wire connection box.

9. Spot and mark positions on the 10-wire connection box where the cables will penetrate.

10. Remove the 10-wire connection box, drill, tap and insert terminal tubes for two MHFA-10 cables, three MHFA-7 cables, one FHFA-3 cable and one DHFA-3 cable, in the locations determined in Step 9.

11. Re-mount the 10-wire connection box on the pads.

12. Install cable straps over the cables and loosely secure to the pads and the wireway.

13. Take up the slack cable and determine the actual length required for each cable to enter the 10-wire connection box. Cut off the excess cable.

14. Prepare the ends of all cables and insert through their respective terminal tubes into the 10-wire connection box.

15. Pack the terminal tubes in the 10-wire connection box.

16. Tighten the cable straps on the pads and the wireway.

17. Install lugs and connect corresponding section wires in all cables to common studs in the 10-wire connection box.

18. Prepare cable end, install lugs and connect DHFA-3 cable to a fused switch on the I.C. switchboard.

19. Install 3-ampere fuses at the switch on the I.C. switchboard.

20. Test the entire system.

LIST OF MATERIAL

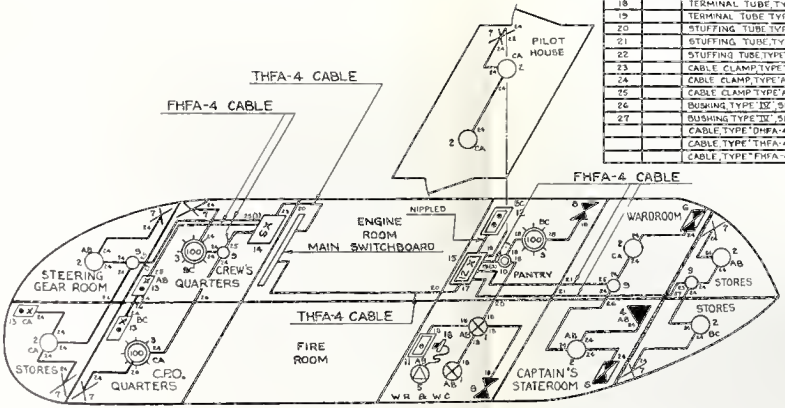
SYM No	SYM	DESCRIPTION	No REQ'D	BU SHIPS DWG No
1	⊘	DECK FIXTURE, TYPE 'J', W.T.	8	9-5-4555-L
2	◯	CEILING FIXTURE, TYPE 'VIII-M', N.W.T.	8	9-5-4665-L
3	✳	100 WATT UNIT, TYPE 'AJ', PERM. W.T.	3	9-5-4596-L
4	A	BERTH FIXTURE, TYPE 'H'	1	9-5-4710-L
5	⊙V	SHADED LIGHT, TYPE 'P'	1	9-5-4558-L
6	S-S	SWITCH, TOGGLE, S.P., TYPE 'SB', N.W.T.	8	9-5-4772-L
7	⌒	SWITCH, SNAP, TYPE 'DD', N.W.T.	7	9-5-4716-L
8	S-S	SWITCH, SNAP, TYPE 'CC', W.T.	1	9-5-4718-L
9	⬡	BRANCH BOX, TYPE 'F', MI, N.W.T.	8	9-5-5066-L
10	⬡	BRANCH BOX, TYPE 'E', W.T.	1	9-5-4260-L
11	⊕	RECEPTACLE, SINGLE, TYPE 'G', W.T.	1	9-5-4264-L
12	⊕⊕	RECEPTACLE, DOUBLE, TYPE 'P', W.T.	1	9-5-4564-L
13	⊕S	SW & SINGLE RECEPT, TYPE 'K', MI, N.W.T.	3	9-5-5055-L
14	⊕X	DISTRIBUTION BOX & CIR, TYPE 'XVI', SIZE 'G'	1	9-5-4754-L
15	⊕X	DISTRIBUTION BOX, JR CIR, TYPE 'XVI', SIZE 'G'	1	9-5-4752-L
16	⊕PL	RECEPTACLE PLUG, TYPE 'D'	1	9-5-4440-L
17		TERMINAL TUBE, TYPE 'XXI', SIZE 'F'	1	9-5-5010-L
18		TERMINAL TUBE, TYPE 'XX', SIZE 'E'	13	9-5-5010-L
19		TERMINAL TUBE TYPE 'XX', SIZE 'D'	4	9-5-5010-L
20		STUFFING TUBE, TYPE 'XXX', SIZE 'F'	3	9-5-5166-L
21		STUFFING TUBE, TYPE 'XXI', SIZE 'G'	2	9-5-5166-L
22		STUFFING TUBE, TYPE 'XVIII', SIZE 'F'	1	9-5-5166-L
23		CABLE CLAMP, TYPE 'A', SIZE 'M'	1	9-5-4562-L
24		CABLE CLAMP, TYPE 'A', SIZE 'H'	44	9-5-4562-L
25		CABLE CLAMP, TYPE 'A', SIZE 'N'	7	9-5-4562-L
26		BUSHING, TYPE 'IV', SIZE 'E'	4	9-5-4268-L
27		BUSHING, TYPE 'IV', SIZE 'G'	2	9-5-4268-L
		CABLE, TYPE 'DHFA-4'	275'	
		CABLE, TYPE 'THFA-4'	35	
		CABLE, TYPE 'FHFA-4'	100	

GENERAL NOTES:-

1- ALL CABLE TO BE TYPE 'DHFA-4', UNLESS OTHERWISE NOTED

REFERENCE DWGS:-

1-GENERAL LIGHTING SYSTEM - ELEMENTARY WIRING DIAGRAM - DWG. No. 6B



GENERAL LIGHTING SYSTEM-ISOMETRIC WIRING DIAGRAM

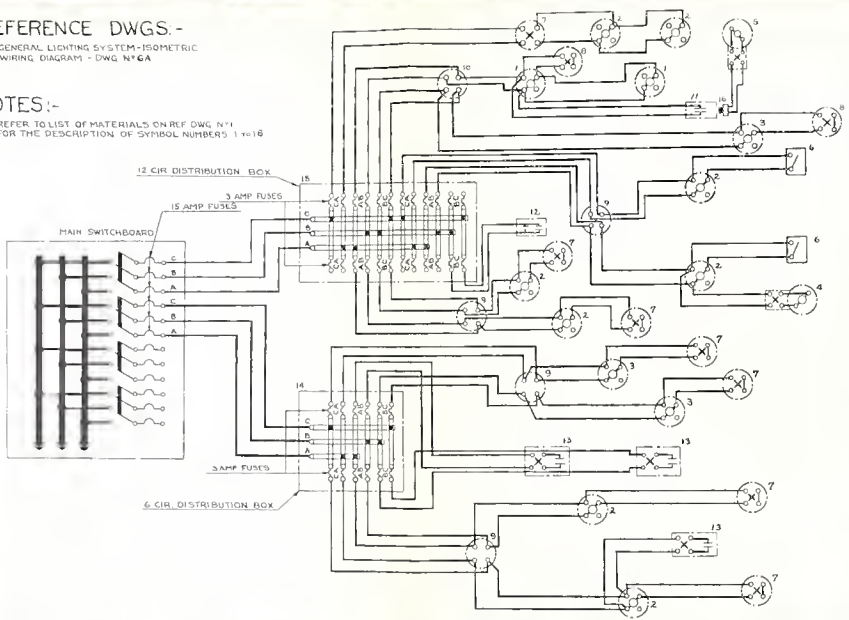
MARINE ELECTRICAL DRAWING No. 6A

REFERENCE DWGS.-

1 GENERAL LIGHTING SYSTEM-ISOMETRIC WIRING DIAGRAM - DWG N°6A

NOTES:-

1- REFER TO LIST OF MATERIALS ON REF DWG N°1 FOR THE DESCRIPTION OF SYMBOL NUMBERS 1 to 16



GENERAL LIGHTING SYSTEM-ELEMENTARY WIRING DIAGRAM

MARINE ELECTRICAL DRAWING N°6B

GENERAL LIGHTING SYSTEM

MARINE ELECTRICAL DRAWINGS 6A and 6B

List of Jobs

Note: Actual cable lengths may be determined by trainees doing individual jobs or by trainees doing Job 12, at the discretion of the instructor.

JOB 1. Install ceiling fixture, snap switch control and associated wiring in the Forward Storeroom, starboard.

Procedure:

1. Spot location in the center of the compartment and install the ceiling fixture on pads on the overhead.

2. Spot location and install the snap switch on the outboard side of the after bulkhead.

3. Select location and have a hole cut in the after end of the inboard bulkhead for a bushing for DHFA-4 cable.

4. Install a bushing in the hole in the inboard bulkhead.

5. Figure the run of cable from the bushing in the inboard bulkhead to the ceiling fixture and from the ceiling fixture to the location of the snap switch.

6. Spot locations and have pads for one-eared straps welded to the overhead, along the run figured in Step 5.

7. Spot and mark positions on the ceiling fixture and the snap switch where cables will penetrate.

8. Remove the ceiling fixture, drill and insert cable clamps for two DHFA-4 cables in the locations determined in Step 7.

9. Remove the snap switch, drill and insert a cable clamp for DHFA-4 cable, in the location determined in Step 7.

10. Reinstall the ceiling fixture and the snap switch.

11. Pull a DHFA-4 cable through the bushing in the inboard bulkhead, starting from the adjacent compartment.

12. Prepare the end of the cable (Step 11) and insert through the cable clamp into the ceiling fixture.

13. Install one-eared cable straps over the cable from the inboard bulkhead to the fixture and secure loosely to the pads.

14. Tighten the cable clamp.

15. Take up the slack cable, passing the excess cable through the bushing into the adjacent compartment.

16. Tighten the cable straps (Step 13).

17. Prepare the end of a DHFA-4 cable and insert through the remaining cable clamp into the ceiling fixture.

18. Install one-eared cable straps over the cable from the ceiling fixture to the after bulkhead and secure loosely to the pads on the overhead.

19. Tighten the cable clamp.

20. Take up the slack cable, pushing the excess cable toward the snap switch.

21. Tighten the cable straps (Step 18).

22. Determine the actual length required to complete the cable run to the snap switch. Cut off the excess cable.

23. Prepare the cable end and insert through the cable clamp into the snap switch and tighten the cable clamp.

24. Install two-eared cable straps over the cable and secure to the after bulkhead.

25. Install lugs and connect the wires of the cables to the ceiling fixture and the snap switch, as shown on Drawing No. 6-B.

26. Assemble the ceiling fixture and the snap switch.

JOB 2. Install ceiling fixture, snap switch control, branch box and associated wiring in the Forward Storeroom, port.

Procedure:

1. Spot location in the center of the compartment and install the ceiling fixture on a strap hanger on the overhead.

2. Spot location and install the snap switch on the outboard side of the after bulkhead.

3. Spot location and install the branch box on pads on the overhead, (aft and inboard).

4. Select location and have a hole cut in the inboard side of the after bulkhead for a bushing for FHFA-4 cable.

5. Install a bushing in the hole in the after bulkhead (Step 4).

6. Figure the runs of cable from the bushing in the after and inboard bulkheads to the branch box, from the branch box to the ceiling fixture and from the ceiling fixture to the snap switch.

7. Spot locations and have pads for one-eared straps welded to the overhead, along the runs figured in Step 6.

8. Spot and mark positions on the ceiling fixture, branch box and snap switch where the cables will penetrate.

9. Remove the ceiling fixture, drill and insert cable clamps for two DHFA-4 cables in locations determined in Step 8.

10. Remove the branch box, drill and insert cable clamps for two DHFA-4 cables and one FHFA-4 cable in locations determined in Step 8.

11. Remove the snap switch, drill and insert a cable clamp for a DHFA-4 cable in the location determined in Step 8.

12. Reinstall the ceiling fixture, branch box and the snap switch.

13. Pull an FHFA-4 cable through after bulkhead, starting from the after compartment.

14. Prepare the end of the FHFA-4 cable (Step 13) and insert through the cable clamp into branch box and tighten cable clamp.

15. Install one-eared straps over the cable from the bushing in the after bulkhead to the branch box and secure loosely to the pads.

16. Take up the slack FHFA-4 cable, passing the excess cable through the bushing into the after compartment.

17. Tighten the cable straps (Step 15).

18. Pick up the DHFA-4 cable at the inboard bulkhead and determine the actual length required to complete the cable run to the branch box. Cut off the excess cable.

19. Prepare the cable end (Step 18) and insert through the cable clamp into the branch box and tighten cable clamp.

20. Install one-eared cable straps over the cable and secure tightly to the pads.

21. Prepare the end of a DHFA-4 cable and insert through the remaining cable clamp into the branch box and tighten the cable clamp. Run the cable toward the ceiling fixture.

22. Install one-eared cable straps over the cable from the branch box to the ceiling fixture and secure loosely to the pads.

23. Take up the slack cable, pushing the excess cable toward the fixture.

24. Determine the actual length required to complete the cable run to the fixture. Cut off the excess cable.

25. Prepare the cable end (Step 24) and insert through a cable clamp into the fixture and tighten the cable clamp.

26. Tighten the cable straps (Step 22).

27. Prepare one end of a DHFA-4 cable and insert through the remaining cable clamp into the ceiling fixture and tighten the clamp. Run the cable toward the snap switch.

28. Install one-eared cable straps over the cable (Step 27) and secure loosely to the pads on the overhead.

29. Take up the slack cable, pushing the excess cable toward the snap switch.

30. Tighten the cable straps (Step 28).

31. Determine the actual length required to complete the cable run to the snap switch. Cut off the excess cable.

32. Prepare the cable end and insert through the cable clamp into the snap switch and tighten the cable clamp.

33. Install two-eared cable straps over the cable and secure tightly to the after bulkhead.

34. Install lugs and connect wires of the cable to the studs in the ceiling fixture, branch box and the snap switch as shown on Drawing 6B.

35. Assemble the branch box, ceiling fixture and the snap switch.

JOB 3. Install ceiling fixture, berth fixture, toggle switch and associated wiring in the Captain's Stateroom.

Procedure:

1. Spot location in the center of the compartment and install the ceiling fixture on pads on the overhead.

2. Spot location and install the toggle switch on the outboard side of the forward bulkhead.

3. Spot location and install the berth fixture on the pads on the forward end of the inboard bulkhead.

4. Select location and have a hole drilled in inboard bulkhead (midway between the forward and after bulkheads) for a bushing for DHFA-4 cable.

5. Install a bushing in the hole in the inboard bulkhead (Step 4).

6. Figure the runs of cable from the bushing in the inboard to the ceiling fixture, from the ceiling fixture to the snap switch and from the ceiling fixture to the berth fixture.

7. Spot locations and have pads for one-eared straps welded to the overhead and the inboard bulkhead along the runs figured in Step 6.

8. Spot and mark positions on the ceiling fixture, berth fixture and the toggle switch where the cables will penetrate.

9. Remove the ceiling fixture, drill and insert cable clamps for three DHFA-4 cables in the locations determined in Step 8.

10. Remove the berth fixture, drill and insert a cable clamp for a DHFA-4 cable, in the location determined in Step 8.

11. Remove the toggle switch, drill and insert a cable clamp for DHFA-4 cable in the location determined in Step 8.

12. Reinstall the ceiling fixture, berth fixture and toggle switch.

13. Pull a DHFA-4 cable through the bushing in the inboard bulkhead, starting from the adjacent compartment.

14. Prepare the end of the cable (Step 13) and insert through a cable clamp into the ceiling fixture and tighten the cable clamp.

15. Install one-eared straps over the cable from the bushing in the inboard bulkhead to the ceiling fixture and loosely secure to pads.

16. Take up the slack cable, passing the excess cable through the bushing into the adjacent compartment.

17. Tighten the cable straps (Step 15).

18. Prepare the end of a DHFA-4 cable and insert through a cable clamp into the ceiling fixture and tighten the clamp. Run the cable toward the toggle switch.

19. Install one-eared cable straps over the cable (Step 18) from the ceiling fixture to the forward bulkhead and secure to the pads on the overhead.

20. Take up the slack cable, pushing the excess cable toward the toggle switch.

21. Tighten the cable straps (Step 19).

22. Determine the actual length required to complete the cable run to the toggle switch. Cut off the excess cable.

23. Prepare the cable end and insert through the cable clamp into the toggle switch and tighten the cable clamp.

24. Install two-eared cable straps over the cable and secure tightly to the forward bulkhead.

25. Prepare the end of a DHFA-4 cable and insert through the remaining cable clamp into the ceiling fixture and tighten the clamp. Run this cable toward the berth fixture.

26. Install one-eared cable straps over the cable from the ceiling fixture to the berth fixture and secure loosely to the pads on the overhead and inboard bulkheads.

27. Take up the slack cable, pushing the excess cable toward the berth fixture.

28. Tighten the cable straps on the overhead.

29. Determine the actual length required to complete the cable run to the berth fixture. Cut off the excess cable.

    Note: Allow a loop of cable at the berth fixture to allow for adjustment of this fixture.

30. Prepare the cable end and insert through the cable clamp into the berth fixture and tighten the cable clamp.

31. Tighten the cable straps on the inboard bulkhead.

32. Install lugs and connect wires of the cables to the studs in the ceiling fixture, berth fixture and the toggle switch as shown on Drawing 6-B.

33. Assemble the ceiling fixture, berth fixture, and the toggle switch.

JOB 4. Install a ceiling fixture, snap switch control, branch box and associated wiring in the Wardroom.

Procedure:

1. Spot location in the center of the compartment and install the ceiling fixture on a strap hanger on the overhead.

2. Spot location and install the toggle switch on the outboard side of the forward bulkhead.

3. Spot location and install the branch box on pads on the overhead, opposite the center of the inboard bulkhead.

4. Select horizontal adjacent locations, spot, center punch and have the after bulkhead drilled for two stuffing tubes for FHFA-4 cables.

5. Install stuffing tubes in the drilled holes in the after bulkhead, starting in the after compartment.

6. Figure the run of cable on the overhead from the outboard stuffing tube in the after bulkhead to the branch box.

7. Figure the run of cable on the overhead from the inboard stuffing tube in the after bulkhead to the bushing in the forward bulkhead. This cable is to be run side by side for the length of the run figured in Step 6.

8. Figure the runs of cable from the bushing in the inboard bulkhead to the branch box, from the branch box to the ceiling fixture and from the ceiling fixture to the toggle switch.

9. Spot locations and have pads for one-eared cable straps welded to the overhead from the forward and inboard bulkheads to the branch box, from the ceiling fixture to a position above the toggle switch along the runs determined in Steps 6, 7, and 8.

10. Spot location and have pads for two-eared cable straps welded to the overhead from the after bulkhead to the branch box.

11. Spot and mark positions on the ceiling fixture, branch box and the toggle switch where the cables will penetrate.

12. Remove the ceiling fixture, drill and insert cable clamps for two DHFA-4 cables in locations determined in Step 11.

13. Remove the branch box, drill and insert cable clamps for two DHFA-4 cables and one FHFA-4 cable in locations determined in Step 11.

14. Remove the toggle switch, drill and insert a cable clamp for a DHFA-4 cable in the location determined in Step 11.

15. Reinstall the ceiling fixture, branch box and the toggle switch.

16. Pull an FHFA-4 cable through the outboard stuffing tube in the after bulkhead, starting from the after compartment.

17. Prepare the end of the FHFA-4 cable (Step 16) and insert through the cable clamp into the branch box and tighten the cable clamp.

18. Pick up the FHFA-4 cable at the forward bulkhead the pass through the inboard stuffing tube in the after bulkhead.

19. Install one-eared straps over the FHFA-4 cable from the forward bulkhead to the branch box and secure loosely to the pads.

20. Install two-eared straps over the two FHFA-4 cables from the branch box to the after bulkhead and secure loosely to the pads.

21. Take up the slack FHFA-4 cable, passing the excess cable through the stuffing tubes into the after compartment.

22. Tighten the cable straps (Steps 19 and 20).

23. Pack the stuffing tubes in the after bulkhead.

24. Pick up the DHFA-4 cable at the inboard bulkhead and determine the actual length required to complete the cable run to the branch box. Cut off the excess cable.

25. Prepare the cable end (Step 24) and insert through the cable clamp into the branch box and tighten the cable clamp.

26. Install one-eared straps over the cable and secure tightly to the pads.

27. Prepare the end of a DHFA-4 cable and insert through the remaining cable clamp into the branch box and tighten the cable clamp. Run this cable toward the ceiling fixture.

28. Install one-eared cable straps over the cable (Step 27) and secure loosely to the pads.

29. Take up the slack cable, pushing the excess cable toward the ceiling fixture.

30. Determine the actual length required to complete the cable run to the ceiling fixture. Cut off the excess cable.

31. Prepare the cable end (Step 30) and insert through a cable clamp into the ceiling fixture and tighten the cable clamp.

32. Tighten the cable straps (Step 28).

33. Prepare one end of a DHFA-4 cable and insert through the remaining cable clamp into the ceiling fixture and tighten the clamp. Run this cable toward the toggle switch.

34. Install one-eared cable straps over the cable (Step 33) and secure loosely to the pads.

35. Take up the slack cable, pushing the excess cable toward the toggle switch.

36. Tighten the cable straps (Step 34).

37. Determine the actual length required to complete the cable run to the toggle switch. Cut off the excess cable.

38. Prepare the cable end and insert through the cable clamp into the toggle switch and tighten the cable clamp.

39. Install two-eared cable straps over the cable and secure tightly to the forward bulkhead.

40. Install lugs and connect wires of the cable to the studs in the ceiling fixture, branch box and toggle switch as shown on Drawing 6B.

41. Assemble the branch box, ceiling fixture and the snap switch.

JOB 5. Install two ceiling fixtures, snap switch control, shaded light, single receptacle and associated wiring in the Washroom and Water Closet.

Procedure:

1. Spot locations and install the ceiling fixtures on pads on the overhead.

   Note: The fixtures should be centrally located between the forward and after bulkheads and 5 feet between centers of fixtures (athwartship).

2. Spot location and install the snap switch on pads on the outboard side of the forward bulkhead.

3. Spot location and install the single receptacle on pads on the after bulkhead, 4 feet from the inboard bulkhead.

4. Spot location and install the shaded light on pads on the after bulkhead, 2 feet from the inboard bulkhead.

5. Select location, spot, center punch and have the inboard bulkhead drilled for a stuffing tube for a DHFA-4 cable, midway between the forward and after bulkheads.

6. Install a stuffing tube in the drilled hole in the inboard bulkhead.

7. Figure the runs of cable from the stuffing tube in the inboard bulkhead to the inboard ceiling fixture, between the ceiling fixtures, from the inboard ceiling fixture to the snap switch and from the inboard ceiling fixture to the single receptacle.

8. Spot locations and have pads for one-eared cable straps welded to the overhead, the forward bulkhead and the after bulkhead along the runs figured in Step 7.

9. Spot and mark positions on the ceiling fixtures, snap switch and single receptacle where the cables will penetrate.

10. Remove inboard ceiling fixture, drill, tap and insert terminal tubes for four DHFA-4 cables, in the locations determined in Step 9.

11. Remove the outboard ceiling fixture, snap switch and single receptacle and drill, tap and insert a terminal tube for a DHFA-4 cable in each, in the location determined in Step 9.

12. Reinstall the two ceiling fixtures, snap switch and single receptacle.

13. Pull a DHFA-4 cable through the stuffing tube in the inboard bulkhead, starting from the adjacent compartment.

14. Prepare the end of the cable (Step 13) and insert through the inboard terminal tube into the inboard ceiling fixture.

15. Install one-eared cable straps over the cable (Step 14) and secure loosely to the pads.

16. Prepare the end of a DHFA-4 cable and insert through the forward terminal tube into the inboard ceiling fixture. Run this cable toward the snap switch.

17. Install one-eared cable straps over the cable (Step 16) and secure loosely to the pads.

18. Determine the actual length required to complete the cable run to the snap switch. Cut off the excess cable.

19. Prepare the cable end and insert through the terminal tube into the snap switch.

20. Prepare the end of a DHFA-4 cable and insert through the outboard terminal tube into the inboard ceiling fixture. Run this cable toward the outboard ceiling fixture.

21. Install one-eared cable straps over the cable (Step 20) and secure loosely to the pads.

22. Determine the actual length required to complete the cable run to the outboard ceiling fixture. Cut off the excess cable.

23. Prepare the cable end (Step 22) and insert through the terminal tube into the outboard ceiling fixture.

24. Prepare the end of a DHFA-4 cable and insert through the remaining terminal tube into the inboard ceiling fixture. Run this cable toward the single receptacle.

25. Install one-eared cable straps over the cable (Step 24) and secure loosely to the pads.

26. Determine the actual length required to complete the cable run to the single receptacle. Cut off the excess cable.

27. Prepare the cable end and insert through the terminal tube into the single receptacle.

28. Pack all terminal tubes.

29. Take up the slack cable from the inboard ceiling fixture to the stuffing tube in the inboard bulkhead, passing the excess cable into the adjacent compartment.

30. Pack the stuffing tube in the inboard bulkhead.

31. Tighten all cable straps.

32. Install lugs and connect wires of the cables to the studs in the ceiling fixtures, snap switch and single receptacle as shown on Drawing 6B.

33. Prepare the end of the flexible cable on the shaded fixture and insert through the terminal tube into the receptacle plug.

    Note: Shaded fixtures are supplied with a length of flexible cable installed.

34. Pack the terminal tube in the receptacle plug.

35. Install lugs and connect wires of the flexible cable to the terminals in the receptacle plug as shown on Drawing 6B.

36. Assemble the ceiling fixtures, snap switch, receptacle and the receptacle plug.

37. Insert the receptacle plug into the receptacle.

JOB 6. Install two ceiling fixtures, snap switch control and associated wiring in the Pilot House.

Procedure:

1. Spot locations and install the ceiling fixtures on pads on the overhead.

   Note: The fixtures should be centrally located between the forward and after bulkheads and 5 feet between centers of fixtures (athwartship).

2. Spot location and install the snap switch on pads on the port bulkhead aft of the access.

3. Select location and have the deck drilled for a stuffing tube for a DHFA-4 cable, directly below the snap switch.

4. Install a stuffing tube and kickpipe in the hole in the deck.

5. Figure the runs of cable from the stuffing tube to the snap switch, from the snap switch to the ceiling fixture on the port side and between the two ceiling fixtures.

6. Spot locations and have pads for one-eared straps welded to the overhead and the port bulkhead, along the runs figured in Step 5.

7. Spot and mark positions on the ceiling fixtures and the snap switch where cables will penetrate.

8. Remove the port ceiling fixture and the snap switch, drill and insert cable clamps for two DHFA-4 cables, in the positions determined in Step 7.

9. Remove the starboard ceiling fixture, drill and insert a cable clamp for a DHFA-4 cable, in the position determined in Step 7.

10. Reinstall the ceiling fixtures and the snap switch.

11. Prepare the end of a DHFA-4 cable and insert through the cable clamp into the starboard fixture and tighten the cable clamp. Run this cable toward the port ceiling fixture.

12. Determine the actual length required to complete the cable run to the port ceiling fixture. Cut off the excess cable.

13. Prepare the cable end (Step 12) and insert through the inboard cable clamp into the port ceiling fixture. Tighten the cable clamp.

14. Install one-eared cable straps over the cable (Step 11) and secure tightly to the pads.

15. Prepare the end of a Type DHFA-4 cable and insert through the remaining cable clamp into the port ceiling fixture and tighten the cable clamp. Run this cable toward the snap switch.

16. Install one-eared cable straps over the cable (Step 15) and secure loosely to the pads on the overhead and the port bulkhead.

17. Determine the actual length required to complete the installation to the snap switch. Cut off the excess cable.

18. Prepare the cable end (Step 17) and insert through the upper cable clamp into the snap switch. Tighten the cable clamp.

19. Tighten the cable straps (Step 16).

20. Pull a DHFA-4 cable through the stuffing tube in the deck, starting from the deck below.

21. Prepare the cable end (Step 20) and insert through the lower cable clamp into the snap switch. Tighten the cable clamp.

22. Install one-eared cable straps over the cable from the snap switch to the stuffing tube and secure loosely to the pads.

23. Take up the slack cable, passing the excess into the compartment below.

24. Pack the stuffing tube.

25. Tighten the cable straps (Step 22).

26. Install lugs and connect wires of the cables to the studs in the ceiling fixtures and the snap switch as shown on Drawing 6B.

27. Assemble the fixtures and snap switch.

JOB 7. Install a 100 watt unit, snap switch control, branch box, double receptacle, 12 circuit distribution box and associated wiring in the Pantry.

Procedure:

1. Spot location in the center of the compartment and install the 100 watt unit on pads on the overhead.

2. Spot location and install the snap switch on pads on the outboard side of the forward bulkhead.

3. Nipple the distribution box and the double receptacle together, using a 3/4" I.P.S. close nipple.

4. Spot location (midway between the inboard bulkheads) and install the distribution box and the double receptacle on pads and "U" brackets on the after bulkhead. Receptacle to be below the distribution box.

5. Spot location and install the branch box on pads on the overhead, midway between the inboard and outboard bulkheads and aft of the 100 watt unit (Step 1).

6. Select location, spot, center punch and have the inboard side of the after bulkhead drilled for a stuffing tube for THFA-4 cable.

7. Install a stuffing tube in the drilled hole in the after bulkhead, starting in the after compartment.

8. Figure the run of cables (side by side) from the stuffing tubes in the forward bulkhead to the distribution box, on the overhead and along the after bulkhead.

9. Figure the run of cable from the stuffing tube in the after bulkhead to the distribution box, along the after bulkhead.

10. Figure the run of cable from the stuffing tube in the inboard bulkhead to the branch box, on the overhead.

11. Figure the run of cable from the stuffing tube in the overhead to the distribution box. This cable should follow the run of cables figured in Step 8, on the after bulkhead.

12. Figure the run of cable from the branch box to the distribution box. This cable should follow the run of cables figured in Step 8, on the after bulkhead.

13. Figure the runs of cable from the branch box to the 100 watt unit and from the 100 watt unit to the snap switch.

14. Spot locations and have pads for two-eared cable straps welded to the overhead and the after bulkhead along the runs figured in Steps 8, 11, and 12.

15. Spot locations and have pads for one-eared cable straps welded to the overhead, and the forward and after bulkheads along the runs figured in Steps 9, 10, 11, 12, and 13.

16. Spot and mark positions on the 100 watt unit, snap switch, branch box and distribution box where cables will penetrate.

17. Remove the 100 watt unit, snap switch, branch box and distribution box, drill, tap and insert terminal tubes for the required number and size of cables, in the locations determined in Step 16.

18. Reinstall the 100 watt unit, snap switch, branch box and distribution box.

19. Prepare the end of a DHFA-4 cable and insert through the forward terminal tube into the branch box. Run this cable toward the 100 watt unit.

20. Install one-eared cable straps over the cable (Step 19) and secure loosely to the pads.

21. Determine the actual length of cable required to complete the cable run to the 100 watt unit. Cut off the excess cable.

22. Prepare the cable end (Step 21) and insert through the after terminal tube into the 100 watt unit.

23. Prepare the end of a DHFA-4 cable and insert through the remaining terminal tube into the 100 watt unit. Run this cable toward the snap switch.

24. Install one-eared cable straps over the cable (Step 23) and secure loosely to the pads.

25. Determine the actual length of cable required to complete the cable run to the snap switch. Cut off the excess cable.

26. Prepare the cable end (Step 25) and insert through the terminal tube into the snap switch.

27. Install one-eared cable straps over the cable (penetrating the inboard bulkhead) from the inboard bulkhead to the branch box, and secure loosely to the pads.

28. Determine the actual length of cable required to complete the cable run (Step 27) to the branch box. Cut off the excess cable.

29. Prepare the cable end (Step 28) and insert through the inboard terminal tube into the branch box.

30. Install one-eared cable straps over the cable (penetrating the overhead) from the point of penetration to the after bulkhead and secure loosely to the pads.

31. Prepare the end of an FHFA-4 cable and insert through the remaining terminal tube into the branch box. Run this cable toward the after bulkhead.

32. Install one-eared cable straps over the cable (Step 31) from the branch box to the after bulkhead and secure loosely to the pads on the overhead.

33. Install two-eared cable straps over the cables (penetrating the forward bulkhead) from the forward bulkhead to the after bulkhead and secure loosely to the pads on the overhead.

34. Pull a THFA-4 cable through the stuffing tube in the after bulkhead, starting from the after compartment.

35. Install one-eared cable straps over the cables (Step 34) and secure loosely to the pads on the after bulkhead.

36. Install two-eared cable straps over the cables on the after bulkhead from the overhead to the distribution box and secure loosely to the pads.

37. Determine the actual lengths of cable required to complete the cable runs to the distribution box. Cut off the excess cable.

38. Prepare the cable ends and insert through the terminal tubes into the distribution box.

39. Pack all the terminal tubes and the stuffing tubes.

40. Tighten all the cable straps.

41. Install lugs and connect wires of the cables to the studs in the 100 watt unit, snap switch, branch box, distribution box and double receptacle as shown on Drawing 6B.

42. Assemble the 100 watt unit, snap switch, branch box, distribution box and double receptacle.

JOB 8. Install ceiling fixture, snap switch control, switch and single receptacle and associated wiring in After Storeroom, starboard.

Procedure:

1. Spot location in the center of the compartment and install the ceiling fixture on an extension hanger on the overhead.

2. Spot location and install the snap switch on the outboard side of the forward bulkhead.

3. Spot location and install the switch and single receptacle on the after end of the inboard bulkhead.

4. Select location and have a hole cut in the forward end of the inboard bulkhead for a bushing for DHFA-4 cable.

5. Install a bushing in the hole in the inboard bulkhead (Step 4).

6. Figure the runs of cable from the bushing in the inboard bulkhead to the ceiling fixture, from the ceiling fixture to the snap switch and from the ceiling fixture to the switch and receptacle.

7. Spot locations and have pads for one-eared cable straps welded to the overhead and the forward bulkhead, along the runs figured in Step 6.

8. Spot and mark positions on the ceiling fixture, snap switch and switch and receptacle where cables will penetrate.

9. Remove the ceiling fixture, snap switch, and the switch and receptacle; drill and insert cable clamps for DHFA-4 cable, in the locations determined in Step 8.

10. Reinstall the ceiling fixture, snap switch and the switch and receptacle.

11. Pull a DHFA-4 cable through the bushing in the inboard bulkhead, starting from the adjacent compartment.

12. Prepare the end of the cable (Step 11) and insert through the forward cable clamp into the ceiling fixture. Tighten the cable clamp.

13. Install one-eared cable straps over the cable (Step 12) and secure loosely to the pads.

14. Take up the slack cable, passing the excess cable through the bushing into the adjacent compartment.

15. Tighten the cable straps (Step 13).

16. Prepare the end of a DHFA-4 cable and insert through the outboard cable clamp into the ceiling fixture and tighten the cable clamp. Run this cable toward the snap switch.

17. Install one-eared cable straps over the cable (Step 16) and secure loosely to the pads.

18. Determine the actual length of cable required to complete the cable run to the snap switch. Cut off the excess cable.

19. Prepare the end of the cable (Step 18) and insert through the cable clamp into the snap switch. Tighten the cable clamp.

20. Tighten the cable straps (Step 17).

21. Prepare the end of a DHFA-4 cable and insert through the remaining cable clamp into the ceiling fixture and tighten the cable clamp. Run this cable toward the switch and receptacle.

22. Install one-eared cable straps over the cable (Step 21) and secure loosely to the pads on the overhead.

23. Take up the slack cable, pushing the excess cable toward the switch and receptacle.

24. Tighten the cable straps (Step 22).

25. Determine the actual length of cable required to complete the cable run to the switch and receptacle. Cut off the excess cable.

26. Prepare the end of the cable (Step 25) and insert through the cable clamp into the switch and receptacle. Tighten the cable clamp.

27. Install two-eared cable straps over the cable and secure to the inboard bulkhead.

28. Install lugs and connect wires of the cables to the studs in the ceiling fixture, snap switch and the switch and receptacle as shown on Drawing 6B.

29. Assemble the ceiling fixture, snap switch and switch and receptacle.

JOB 9. Install ceiling fixture, snap switch control, branch box and associated wiring in the Steering Gear Room.

Procedure:

1. Spot location in the center of the compartment and install the ceiling fixture on pads on the overhead.

2. Spot location, midway between the inboard and outboard bulkheads and forward of the ceiling fixture and mount the branch box on pads on the overhead.

3. Spot location and install the snap switch on the outboard side of the forward bulkhead.

4. Select location, spot, center punch and have the forward bulkhead drilled for a bushing for an FHFA-4 cable, midway between the inboard and outboard bulkheads.

5. Install a bushing in the drilled hole in the forward bulkhead.

6. Figure the runs of cable from the bushings in the forward and inboard bulkheads to the branch box, from the branch box to the ceiling fixture, and from the ceiling fixture to the snap switch.

7. Spot locations and have pads for one-eared cable straps welded to the overhead and forward bulkhead, along the runs figured in Step 6.

8. Spot and mark positions on the ceiling fixture, branch box and snap switch where the cables will penetrate.

9. Remove the ceiling fixture, branch box and snap switch; drill and insert cable clamps for the required number and sizes of cables, in the locations determined in Step 8.

10. Reinstall the ceiling fixture, branch box and snap switch.

11. Pull an FHFA-4 cable through the bushing in the forward bulkhead, starting from the forward compartment.

12. Prepare the end of the cable (Step 11) and install through the forward cable clamp into the branch box. Tighten the cable clamp.

13. Install one-eared cable straps over the cable (Step 12) from the branch box to the forward bulkhead and secure loosely to the pads.

14. Take up the slack cable, passing the excess cable into the forward compartment. Tighten the cable straps (Step 13).

15. Install one-eared cable straps over the cable (penetrating the inboard bulkhead) from the inboard bulkhead to the branch box and secure loosely to the pads.

16. Determine the actual length of cable required to complete the cable run (Step 15) to the branch box. Cut off the excess cable.

17. Prepare the cable end (Step 16) and insert through the inboard cable clamp into the branch box. Tighten the cable clamp.

18. Tighten the cable straps (Step 15).

19. Prepare the end of a DHFA-4 cable and install through the remaining cable clamp into the branch box and tighten the cable clamp. Run this cable toward the ceiling fixture.

20. Install one-eared cable straps over the cable (Step 19) and secure loosely to the pads.

21. Determine the actual length of cable required to complete the cable run (Step 19) to the ceiling fixture. Cut off the excess cable.

22. Prepare the cable end (Step 21) and insert through the forward cable clamp into the ceiling fixture. Tighten the cable clamp.

23. Tighten the cable straps (Step 20).

24. Prepare the end of a DHFA-4 cable and insert through the remaining cable clamp into the ceiling fixture and tighten the cable clamp. Run this cable toward the snap switch.

25. Install one-eared cable straps over the cable (Step 24) from the ceiling fixture to the snap switch and secure loosely to the pads.

26. Determine the actual length of cable required to complete the cable run (Step 24) to the snap switch. Cut off the excess cable.

27. Prepare the cable end (Step 26) and insert through the cable clamp into the snap switch. Tighten the cable clamp.

28. Tighten the cable straps (Step 25).

29. Install lugs and connect wires of the cables to the studs in the ceiling fixture, branch box and the snap switch, as shown on Drawing 6B.

30. Assemble the ceiling fixture, branch box and the snap switch.

JOB 10. Install 100 watt unit, snap switch control, switch and single receptacle and associated wiring in the C.P.O. Quarters.

Procedure:

1. Spot location in the center of the compartment and install the 100 watt unit on pads on the overhead.

2. Spot location and install the snap switch on pads on the outboard side of the after bulkhead.

3. Spot location three feet from the inboard bulkhead and install the switch and receptacle on pads on the after bulkhead.

4. Select locations, spot, center punch and have inboard bulkhead drilled for two bushings for Type DHFA-4 cable.

   Note: One location to be midway between the forward and after bulkheads and one location to be close to the after bulkhead.

5. Install bushings in the drilled holes in the inboard bulkhead.

6. Figure runs of cable from the forward bushing in the inboard bulkhead to the 100 watt unit, from the after bushing in the inboard bulkhead to the switch and receptacle and from the 100 watt unit to the snap switch.

7. Spot locations and have pads for one-eared cable straps welded to the overhead and after bulkhead, along the runs figured in Step 6.

8. Spot and mark positions on the 100 watt unit, snap switch and the switch and receptacle, where the cables will penetrate.

9. Remove the 100 watt unit, switch, and receptacle, and the snap switch; drill and insert cable clamps for DHFA-4 cable, in the locations determined in Step 8.

10. Reinstall the 100 watt unit, snap switch and the switch and receptacle.

11. Pull a DHFA-4 cable through the forward bushing in the inboard bulkhead, starting from the adjacent compartment.

12. Prepare the end of the cable (Step 11) and insert through the inboard cable clamp into the 100 watt unit. Tighten the cable clamp.

13. Install one-eared cable straps over this cable from the inboard bulkhead to the 100 watt unit and secure loosely to the pads.

14. Take up the slack cable, passing the excess cable through the bushing into the adjacent compartment.

15. Tighten the cable straps (Step 13).

16. Pull a DHFA-4 cable through the after bushing in the inboard bulkhead, starting from the adjacent compartment.

17. Prepare the end of the cable (Step 16) and insert through the cable clamp into the switch and receptacle. Tighten the cable clamp.

18. Install one-eared cable straps over the cable (Step 17) from the inboard bulkhead to the switch and receptacle and secure loosely to the pads.

19. Take up the slack cable, passing the excess cable through the bushing into the adjacent compartment.

20. Tighten the cable straps (Step 18).

21. Prepare the end of a DHFA-4 cable and insert through the remaining cable clamp into the 100 watt unit and tighten the cable clamp. Run this cable toward the snap switch.

22. Install one-eared cable straps over the cable (Step 21) from the 100 watt unit to the snap switch and secure loosely to the pads.

23. Determine the actual length of cable required to complete the cable run (Step 22) to the snap switch. Cut off the excess cable.

24. Prepare the cable end (Step 23) and insert through the cable clamp into the snap switch. Tighten the cable clamp.

25. Tighten the cable straps (Step 22).

26. Install lugs and connect wires of the cables to the studs in the 100 watt unit, snap switch and the switch and receptacle, as shown in Drawing 6B.

27. Assemble the 100 watt unit, snap switch and the switch and receptacle.

JOB 11. Install 100 watt unit, snap switch control, switch and single receptacle, branch box, distribution box and associated wiring in the Crew's Quarters.

Procedure:

1. Spot location in the center of the compartment and install the 100-watt unit on pads on the overhead.

2. Spot location, midway between the inboard and outboard bulkheads and forward of the 100 watt unit and install the branch box on pads on the overhead.

3. Spot location and install the snap switch on pads on the outboard side of the after bulkhead.

4. Spot location and install the switch and receptacle on the inboard side of the after bulkhead.

5. Spot location and install the distribution box on pads on the outboard side of the forward bulkhead.

6. Select location, spot, center punch and have the outboard side of the forward bulkhead drilled for a stuffing tube for a Type THFA-4 cable.

7. Install a stuffing tube in drilled hole in forward bulkhead, starting from the forward compartment.

8. Figure the runs of cable from the branch box to the 100 watt unit, from the 100 watt unit to the snap switch, from the forward bushing in the inboard bulkhead to the branch box and from the after bushing in the inboard bulkhead to the switch and receptacle.

9. Figure the runs of cable from the distribution box to the bushing in the after bulkhead, from the distribution box to the switch and receptacle, from the stuffing tube in the forward bulkhead to the distribution box and from the distribution box to the branch box. Run these cables side by side for as great a distance as practicable.

10. Spot locations and have pads for two-eared cable straps welded to the forward and after bulkheads and the overhead along the runs figured in Step 9.

11. Spot locations and have pads for one-eared cable straps welded to the overhead and the after bulkhead along the runs figured in Step 8 and from the branching off points to the switch and receptacle and to the branch box.

12. Spot and mark positions on the 100 watt unit, branch box, snap switch, distribution box and the switch and receptacle, where cables will penetrate.

13. Remove the 100 watt unit, branch box, snap switch, distribution box and switch and receptacle, drill and insert cable clamps for the required number and size of cables, in the locations determined in Step 12.

14. Reinstall the 100 watt unit, branch box, snap switch, distribution box and the switch and receptacle.

15. Pull a THFA-4 cable through the stuffing tube in the forward bulkhead, starting from the Engine Room.

16. Prepare the end of the cable (Step 15) and insert through a cable clamp into the distribution box. Tighten the cable clamp.

17. Prepare the end of an FHFA-4 cable and insert through a cable clamp into the distribution box and tighten the cable clamp. Run this cable toward the switch and receptacle.

18. Install two-eared cable straps over the cables (Steps 16 and 17) and secure loosely to the pads on the forward bulkhead.

19. Install two-eared cable straps over the cable (Step 17) from the forward bulkhead to the bushing in the after bulkhead and secure loosely to the pads.

20. Pick up the cable at the bushing in the after bulkhead and pull through the two-eared cable straps (Steps 18 and 19) to the distribution box.

21. Determine the actual length of cable (Step 20) required to complete the cable run to the distribution box. Cut off the excess cable.

22. Prepare the end of the cable (Step 21) and insert through a cable clamp into the distribution box. Tighten the cable clamp.

23. Pull an FHFA-4 cable through the two-eared cable straps from the branching off point (to the branch box) to the distribution box.

24. Prepare the end of the cable (Step 23) and insert through the remaining cable clamp into the distribution box and tighten the cable clamp.

25. Install one-eared cable straps over the cable (Step 23) from the branching off point to the branch box.

26. Determine the actual length of cable required to complete the cable run to the branch box. Cut off the excess cable.

27. Prepare the end of the cable (Step 26) and install through the outboard cable clamp into the branch box. Tighten the cable clamp.

28. Take up the slack cable (Step 15) and pass the excess through the stuffing tube into the engine room.

29. Take up the slack cable (Step 17) and push the excess toward the switch and receptacle.

30. Tighten the two-eared cable straps (Steps 18 and 19).

31. Pick up the cable at the forward bushing in the inboard bulkhead and run toward the branch box.

32. Install one-eared cable straps over the cable (Step 31) and secure loosely to the pads.

33. Determine the actual length of cable (Step 31) required to complete the cable run to the branch box. Cut off the excess cable.

34. Prepare the cable end (Step 33) and insert through the inboard cable clamp into the branch box. Tighten the cable clamp.

35. Tighten the cable straps (Step 32).

36. Prepare the end of a DHFA-4 cable and insert through the remaining cable clamp into the branch box and tighten the cable clamp. Run this cable toward the 100 watt unit.

37. Install one-eared cable straps over the cable (Step 36) and secure loosely to the pads.

38. Determine the actual length of cable (Step 36) required to complete the cable run to the 100 watt unit. Cut off the excess cable.

39. Prepare the cable end (Step 38) and insert through the forward cable clamp into the 100 watt unit. Tighten the cable clamp.

40. Tighten the cable straps (Step 37).

41. Prepare the end of a DHFA-4 cable and insert through the remaining cable clamp into the 100 watt unit and tighten the cable clamp. Run this cable toward the snap switch.

42. Install one-eared cable straps over the cable (Step 41) and secure loosely to the pads.

43. Determine the actual length of cable (Step 41) required to complete the cable run to the snap switch. Cut off the excess cable.

44. Prepare the cable end (Step 43) and insert through the cable clamp into the snap switch. Tighten the cable clamp.

45. Tighten the cable straps (Step 42).

46. Pick up the FHFA-4 cable (Step 17) at the branching off point and run toward the switch and receptacle.

47. Install one-eared cable straps over the cable (Step 46) and secure loosely to the pads.

48. Determine the actual length of cable (Step 46) required to complete the cable run to the switch and receptacle. Cut off the excess cable.

49. Prepare the cable end (Step 48) and insert through a cable clamp into the switch and receptacle. Tighten the cable clamp.

50. Tighten the cable straps (Step 47).

51. Pick up the cable at the after bushing in the inboard bulkhead and run it toward the switch and receptacle.

52. Install one-eared cable straps over the cable (Step 51) and secure loosely to the pads.

53. Determine the actual length of cable (Step 51) required to complete the cable run to the switch and receptacle. Cut off the excess cable.

54. Prepare the cable end (Step 53) and insert through the remaining cable clamp into the switch and receptacle. Tighten the cable clamp.

55. Tighten the cable straps (Step 52).

56. Pack the stuffing tube in the forward bulkhead.

57. Install lugs and connect wires of the cables to the studs in the 100 watt unit, branch box, snap switch, switch and receptacle and distribution box as shown on Drawing 6B.

58. Assemble the 100 watt unit, snap switch, branch box, distribution box, and the switch and receptacle.

JOB 12. Install general lighting system wiring in the Engine Room and connect to 115 volt, 3 phase, 60 cycle supply.

Procedure:

1. Figure the run of cable along the inboard and after bulkhead from the stuffing tube in the forward bulkhead to the main switchboard.

2. Figure the run of cable from the stuffing tube in the after bulkhead to the main switchboard.

3. Spot locations and have pads for one-eared cable straps welded to the inboard and after bulkheads, along the runs figured in Steps 1 and 2.

4. Pick up the cable at the forward bulkhead and run it toward the main switchboard.

5. Install one-eared cable straps over the cable (Step 4) from the forward bulkhead to the main switchboard and secure loosely to the pads.

6. Pick up the cable at the after bulkhead and run it toward the main switchboard.

7. Install one-eared cable straps over the cable (Step 6) from the after bulkhead to the main switchboard and secure loosely to the pads.

8. Determine the actual lengths of cable required to complete the cable runs to the switchboard. Cut off the excess cable.

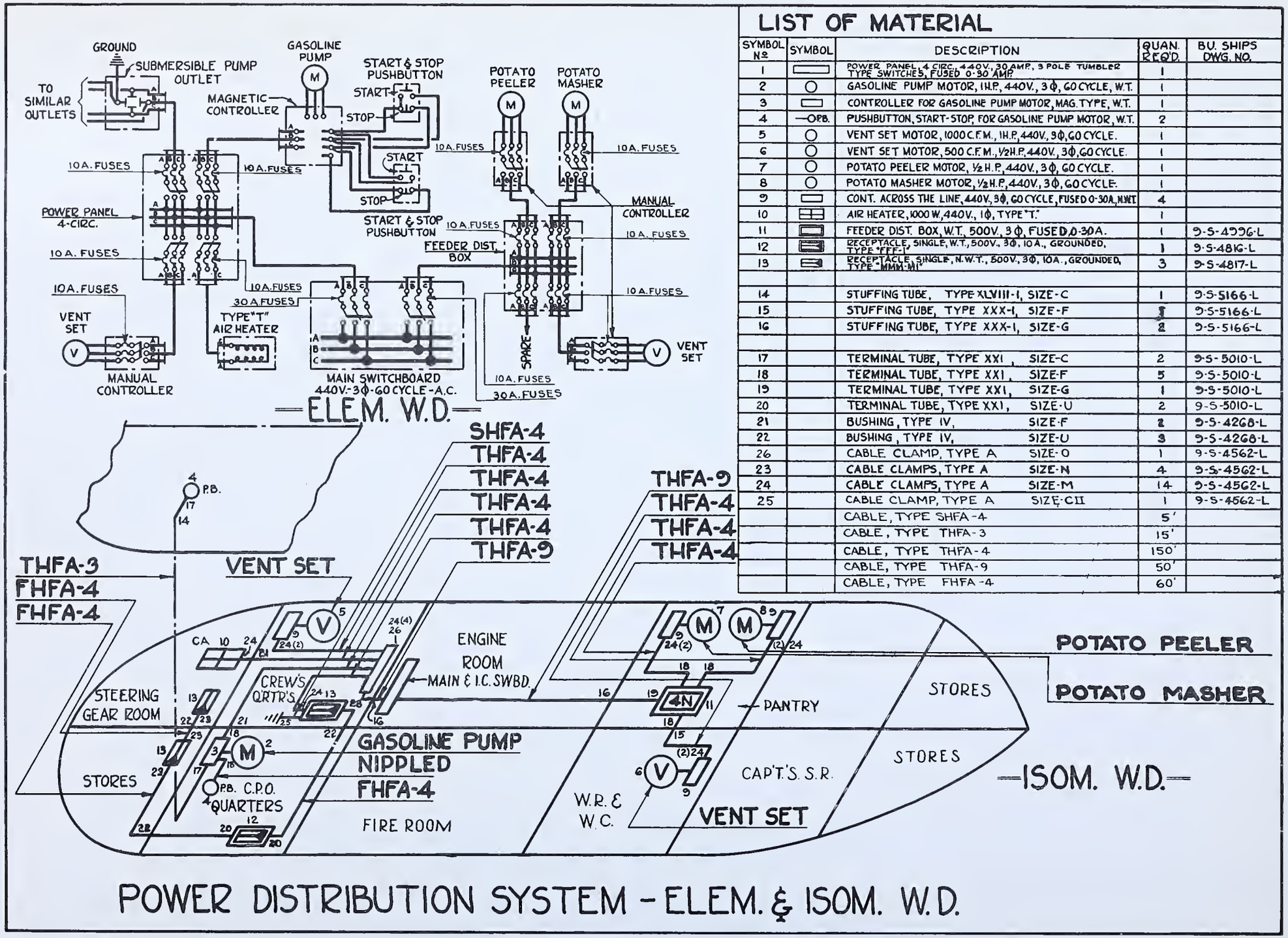
9. Tighten all cable straps (Steps 5 and 7).

10. Prepare the cable ends, install lugs and secure to switches on the main switchboard as shown on Drawing 6B.

11. Install 3-ampere fuses in distribution boxes in the Crew's Quarters and the Pantry.

12. Install 15-ampere fuses in the switches on the main switchboard.

13. Assist trainees (on other jobs) to complete and test all general lighting system installations.



LIST OF MATERIAL

SYMBOL Nº	SYMBOL	DESCRIPTION	QUAN. REQ'D.	B.U. SHIPS DWG. NO.
1		POWER PANEL 4 CIRC. 440V. 30 AMP. 3 POLE TUMBLER TYPE SWITCHES, FUSED 0-30 AMP	1	
2		GASOLINE PUMP MOTOR, 1H.P, 440V., 3Φ, 60 CYCLE, W.T.	1	
3		CONTROLLER FOR GASOLINE PUMP MOTOR, MAG. TYPE, W.T.	1	
4	—PB.	PUSHBUTTON, START-STOP, FOR GASOLINE PUMP MOTOR, W.T.	2	
5		VENT SET MOTOR, 1000 C.F.M., 1H.P, 440V, 3Φ, 60 CYCLE.	1	
6		VENT SET MOTOR, 500 C.F.M., ½H.P, 440V., 3Φ, 60 CYCLE.	1	
7		POTATO PEELER MOTOR, ½ H.P, 440V., 3Φ, 60 CYCLE.	1	
8		POTATO MASHER MOTOR, ½ H.P, 440V., 3Φ, 60 CYCLE.	1	
9		CONT. ACROSS THE LINE, 440V, 3Φ, 60 CYCLE, FUSED 0-30A, N.W.T.	4	
10		AIR HEATER, 1000 W, 440V., 1Φ, TYPE "T."	1	
11		FEEDER DIST. BOX, W.T. 500V, 3Φ, FUSED 0-30A.	1	9-5-4006-L
12		RECEPTACLE, SINGLE, W.T., 500V., 3Φ, 10A., GROUNDED, TYPE "FFF-1"	1	9-5-4816-L
13		RECEPTACLE, SINGLE, N.W.T., 500V, 3Φ, 10A., GROUNDED, TYPE "MMM-M1"	3	9-5-4817-L
14		STUFFING TUBE, TYPE XLVIII-1, SIZE-C	1	9-5-5166-L
15		STUFFING TUBE, TYPE XXX-1, SIZE-F	1	9-5-5166-L
16		STUFFING TUBE, TYPE XXX-1, SIZE-G	2	9-5-5166-L
17		TERMINAL TUBE, TYPE XXI, SIZE-C	2	9-5-5010-L
18		TERMINAL TUBE, TYPE XXI, SIZE-F	5	9-5-5010-L
19		TERMINAL TUBE, TYPE XXI, SIZE-G	1	9-5-5010-L
20		TERMINAL TUBE, TYPE XXI, SIZE-U	2	9-5-5010-L
21		BUSHING, TYPE IV, SIZE-F	2	9-5-4268-L
22		BUSHING, TYPE IV, SIZE-U	3	9-5-4268-L
26		CABLE CLAMP, TYPE A SIZE-O	1	9-5-4562-L
23		CABLE CLAMPS, TYPE A SIZE-N	4	9-5-4562-L
24		CABLE CLAMPS, TYPE A SIZE-M	14	9-5-4562-L
25		CABLE CLAMP, TYPE A SIZE-CII	1	9-5-4562-L
		CABLE, TYPE SHFA-4	5'	
		CABLE, TYPE THFA-3	15'	
		CABLE, TYPE THFA-4	150'	
		CABLE, TYPE THFA-9	50'	
		CABLE, TYPE FHFA-4	60'	

POWER DISTRIBUTION SYSTEM - ELEM. & ISOM. W.D.

MARINE ELECTRICAL DRAWING Nº 7

POWER DISTRIBUTION SYSTEM

MARINE ELECTRICAL DRAWING NO. 7

List of Jobs

Notes: 1. Actual cable lengths may be determined by trainees doing individual jobs or by trainees doing Job 7, at the discretion of the instructor.

2. Motors and their driven auxiliaries are supported and installed by machinists. After the installation of the motor driven auxiliaries the electricians must provide electrical power supply.

JOB 1. Install controller and associated wiring for vent set in Washroom and Water Closet.

Procedure:

1. Select location and install the controller on pads on the inboard side of the forward bulkhead.

2. Select location, spot, center punch and have the forward end of the inboard bulkhead drilled for a stuffing tube for a THFA-4 cable.

3. Install a stuffing tube in the hole in the inboard bulkhead.

4. Figure the run of cable from the stuffing tube to the controller, along the inboard and forward bulkheads.

5. Spot locations and have pads for one-eared cable straps welded to the inboard and forward bulkheads, along the run figured in Step 4.

6. Determine and mark the locations where the cable from the motor (see Drawing 7) and the supply cable will penetrate the controller.

7. Remove the controller, drill and insert cable clamps for two THFA-4 cables, in the locations determined in Step 6.

8. Reinstall the controller.

9. Pull a THFA-4 cable through the stuffing tube in the inboard bulkhead, starting from the Pantry. Run this cable toward the controller.

10. Prepare the cable end (Step 9) and insert through a cable clamp into the controller. Tighten the cable clamp.

11. Install one-eared cable straps over the cable (Step 9) from the inboard bulkhead to the controller and secure loosely to the pads.

12. Take up the slack cable, passing the excess through the stuffing tube into the Galley.

13. Tighten the cable straps (Step 11).

14. Pack the stuffing tube in the inboard bulkhead.

15. Figure the run of cable from the controller to the motor along the forward bulkhead and the overhead.

16. Spot locations and have pads for one-eared cable straps welded to the forward bulkhead and the overhead, along the run figured in Step 15.

17. Prepare the end of a THFA-4 cable and insert through the remaining cable clamp into the controller and tighten the cable clamp. Run this cable toward the motor.

18. Install one-eared cable straps over the cable (Step 17) from the controller to the motor and secure loosely to the pads.

19. Determine the actual length of cable required to complete the cable run (Step 18) to the motor, allowing sufficient slack (at the motor) for vibration of the motor. Cut off the excess cable.

20. Prepare the cable end (Step 19) and insert through the cable clamp provided on terminal box of the motor. Tighten the cable clamp.

21. Tighten the cable straps (Step 18).

22. Install lugs and connect wires of the cables to the studs in the motor terminal box and the controller as shown on the elementary wiring diagram of Drawing 7.

23. Assemble the motor terminal box and the controller.

JOB 2. Install a feeder distribution box, controller for potato peeler, controller for potato masher and associated wiring in the Galley.

Procedure:

1. Select location and install the feeder distribution box on pads on the inboard bulkhead, midway between the forward and after bulkheads.

2. Select location and install the controller for the potato masher motor on the outboard side of the forward bulkhead.

3. Select location and install the controller for the potato peeler motor on the outboard side of the after bulkhead.

4. Select location, spot, center punch and have the inboard side of the after bulkhead drilled for stuffing tube for a THFA-9 cable.

5. Install a stuffing tube in the hole in the after bulkhead, starting from the after compartment.

6. Figure the runs of cable from the stuffing tube in the after and inboard bulkheads to the distribution box along the inboard bulkhead.

7. Figure the run of cable from the distribution box to the controller for the potato peeler, along the inboard and after bulkheads.

   Note: This cable should be run side by side with the supply cable (Step 6) from the distribution box to the after bulkhead.

8. Figure the run of cable from the distribution box to the controller for the potato masher, along the inboard and forward bulkheads.

   Note: This cable should be run side by side with the cable to the vent in the W. R. and W. C., from the distribution box to the forward bulkhead.

9. Spot locations and have pads for one-eared cable straps welded to the forward and after bulkheads along the runs figured in Steps 7 and 8.

10. Spot locations and have pads for two-eared cable straps welded to the inboard bulkhead along the runs figured in Steps 6, 7 and 8.

11. Spot and mark positions on the distribution box and the controllers, where the cables will penetrate.

    Note: Locations should also be center punched on the controllers where cables from the motor will penetrate.

12. Remove the distribution box, drill and insert terminal tubes for the required number and size of cables, in the locations determined in Step 11.

13. Remove the controllers, drill and insert cable clamps for THFA-4 cables, in the locations determined in Step 11.

14. Reinstall the distribution box and controllers.

15. Pull a THFA-9 cable through the stuffing tube in the after bulkhead, starting from the Engine Room. Run this cable toward the distribution box.

16. Prepare the cable end (Step 15) and insert through the terminal tube into the distribution box.

17. Install two-eared cable straps over the cable (Step 15) from the distribution box to the after bulkhead and secure loosely to the pads.

18. Prepare the end of a THFA-4 cable and insert through a terminal tube into the distribution box. Pull this cable through the two-eared cable straps (Step 17) from the distribution box to the after bulkhead.

19. Pick up the THFA-4 cable at the branching off point (Step 18) and run toward the controller for the potato peeler motor.

20. Install one-eared cable straps over the cable (Step 19) and secure loosely to the pads on the after bulkhead.

21. Determine the actual length of cable required to complete the cable run (Step 19) to the controller for the potato peeler motor. Cut off the excess cable.

22. Prepare the cable end (Step 21) and insert through a cable clamp into the potato peeler motor controller. Tighten the cable clamp.

23. Prepare the end of a THFA-4 cable and insert through a terminal tube into the distribution box. Run this cable toward the controller for the potato masher motor.

24. Install two-eared cable straps over the cable (Step 23) from the distribution box to the forward bulkhead and secure loosely to the pads.

25. Install one-eared cable straps over the cable (Step 23) and secure loosely to the pads on the forward bulkhead.

26. Determine the actual length of cable required to complete the cable run (Step 23) to the controller for the potato masher motor. Cut off the excess cable.

27. Prepare the cable end (Step 26) and insert through a cable clamp into the potato masher motor controller. Tighten the cable clamp.

28. Pick up the cable at the stuffing tube in the inboard bulkhead and pass through the two-eared cable straps (Step 24) to the distribution box.

29. Determine the actual length of cable required to complete the cable run (Step 28) to the distribution box. Cut off the excess cable.

30. Prepare the cable end (Step 29) and insert through the remaining stuffing tube into the distribution box.

31. Pack all the terminal tubes and the stuffing tubes.

32. Tighten all the cable straps (Steps 17, 20, 24 and 25).

33. Figure the runs of cable from the controllers to the respective motors.

34. Spot locations and have pads for one-eared cable straps welded to the forward and after bulkheads, along the runs figured in Step 33.

35. Prepare the end of a THFA-4 cable and insert through the remaining cable clamp into the controller for the potato peeler motor and tighten the cable clamp. Run this cable toward the potato peeler motor.

36. Install one-eared cable straps over the cable (Step 35) and secure loosely to the pads.

37. Determine the actual length of cable required to complete the cable run (Step 35) to the potato peeler motor, allowing sufficient slack (at the motor) for vibration of the motor. Cut off the excess cable.

38. Prepare the cable end (Step 37) and insert through the terminal tube provided on the terminal box of the potato peeler motor.

39. Tighten the cable straps (Step 36).

40. Prepare the end of a THFA-4 cable and insert through the remaining cable clamp into the controller for the potato masher motor and tighten the cable clamp. Run this cable toward the potato masher motor.

41. Install one-eared cable straps over the cable (Step 40) and secure loosely to the pads.

42. Determine the actual length of cable required to complete the cable run (Step 40) to the potato masher motor, allowing sufficient slack (at the motor) for vibration of the motor. Cut off the excess cable.

43. Prepare the cable end (Step 42) and insert through the terminal tube provided on the terminal box of the potato masher motor.

44. Pack the terminal tubes in the terminal boxes of the motors.

45. Tighten the cable straps (Step 41).

46. Install lugs and connect wires of the cables to the studs in the distribution box, motor terminal boxes and controllers, as shown on the elementary wiring diagram of Drawing 7.

47. Assemble the distribution box, controllers and motor terminal boxes.

JOB 3. Install an air heater, a submersible pump outlet and associated wiring in the Steering Gear Room.

Procedure:

1. Select location and install the air heater on "U" brackets on the forward bulkhead, midway between the inboard and outboard bulkheads.

2. Select location and install the single receptacle on pads on the inboard side of the forward bulkhead.

3. Select location, spot, center punch and have the forward bulkhead drilled for a bushing for a THFA-4 cable, directly above the air heater.

4. Install a bushing in the hole in the forward bulkhead.

5. Select location and have a hole cut in the forward end of the inboard bulkhead for an FHFA-4 cable.

6. Install a bushing in the hole in the inboard bulkhead.

7. Figure the run of cable from the bushing in the forward bulkhead to the air heater.

8. Figure the run of cable from the bushing in the inboard bulkhead to the single receptacle.

9. Spot locations and have pads for one-eared cable straps welded to the forward bulkhead, along the runs figured in Steps 7 and 8.

10. Spot and mark positions on the air heater and the receptacle where cables will penetrate.

11. Remove the air heater and the receptacle, drill and insert cable clamps in the locations determined in Step 10.

12. Reinstall the air heater and the receptacle.

13. Pull a THFA-4 cable through the bushing in the forward bulkhead starting from the forward compartment. Run this cable to the air heater.

14. Prepare the cable end (Step 13) and insert through the cable clamp into the air heater. Tighten the cable clamp.

15. Install one-eared cable straps over the cable (Step 13) and secure loosely to the pads.

16. Take up the slack cable (Step 13) passing the excess cable into the forward compartment.

17. Tighten the cable straps (Step 15).

18. Pull an FHFA-4 cable through the bushing in the inboard bulkhead, starting from the adjacent compartment. Run this cable toward the receptacle.

19. Prepare the cable end (Step 18) and insert through the cable clamp into the receptacle. Tighten the cable clamp.

20. Install one-eared cable straps over the cable (Step 18) and secure loosely to the pads.

21. Take up the slack cable (Step 18) passing the excess cable into the adjacent compartment.

22. Tighten the cable straps (Step 20).

23. Install lugs and connect wires of the cables to the studs in the air heater and the single receptacle, as shown on the elementary wiring diagram of Drawing 7.

24. Assemble air heater and the single receptacle.

JOB 4. Install a submersible pump outlet and associated wiring in the After Storeroom, starboard.

Procedure:

1. Select location and install the single receptacle on "U" brackets on the inboard side of the forward bulkhead.

2. Select location, spot, center punch and have the outboard side of the forward bulkhead drilled for a bushing for an FHFA-4 cable.

3. Install a bushing in the hole in the forward bulkhead.

4. Figure the run of cable from the bushing in the forward bulkhead to the receptacle.

5. Figure the run of cable from the bushing in the inboard bulkhead to the receptacle.

   Note: This cable should be run side by side with the cable figured in Step 4, from the overhead to the receptacle.

6. Spot locations and have pads for two-eared cable straps welded to the forward bulkhead from the overhead to the receptacle, along the runs figured in Steps 4 and 5.

7. Spot locations and have pads for one-eared cable straps welded to the forward bulkhead from the branching off point (Step 6) to the bushings, along the runs figured in Steps 4 and 5.

8. Spot and mark positions on the receptacle where the cables will penetrate.

9. Remove the receptacle, drill and insert cable clamps for two FHFA-4 cables in locations determined in Step 8.

10. Reinstall the receptacle.

11. Pick up the FHFA-4 cable at the bushing in the inboard bulkhead and run it to the receptacle.

12. Install two-eared cable straps over the cable (Step 11) from the receptacle to the overhead and secure loosely to the pads.

13. Install one-eared cable straps over the cable (Step 11) from the branching off point to the inboard bulkhead and secure loosely to the pads.

14. Determine the actual length of cable required to complete the cable run (Step 11) to the receptacle. Cut off the excess cable.

15. Prepare the cable end (Step 14) and insert through a cable clamp into the receptacle. Tighten the cable clamp.

16. Pull an FHFA-4 cable through the bushing in the forward bulkhead, starting from the forward compartment. Run this cable toward the receptacle.

17. Pull the cable (Step 16) through the two-eared cable straps, from the overhead to the receptacle.

18. Install one-eared cable straps over the cable from the branching off point to the bushing in the forward bulkhead and secure loosely to the pads.

19. Determine the actual length of cable required to complete the cable run (Step 16) to the receptacle. Cut off the excess cable.

20. Prepare the cable end (Step 19) and insert through the remaining cable clamp into the receptacle. Tighten the cable clamp.

21. Take up the slack cable (Step 16), pushing the excess through the bushing into the forward compartment.

22. Tighten all cable straps.

23. Install lugs and connect wires of the cable to the studs in the receptacle, as shown on the elementary wiring diagram of Drawing 7.

24. Assemble the single receptacle.

JOB 5. Install a start-stop pushbutton for the gasoline pump and associated wiring on the Upper Deck, aft.

Procedure:

1. Select location and install the start-stop pushbutton on a pipe stanchion at the starboard rail, directly above the after end of the C.P.O. quarters.

2. Select location, spot, center punch and have the deck drilled for a stuffing tube for a THFA-3 cable, directly below the start-stop pushbutton.

3. Install a stuffing tube and kickpipe in the hole in the deck.

4. Figure the run of cable (on the pipe stanchion) from the kickpipe to the start-stop pushbutton.

5. Spot locations and have stanchion drilled and tapped for machine screws for one-eared cable straps along the cable run figured in Step 4.

6. Spot and mark the position on the start-stop pushbutton where the cable will penetrate.

7. Remove the start-stop pushbutton, drill, tap and insert a terminal tube for THFA-3 cable.

8. Reinstall the start-stop pushbutton.

9. Pull a THFA-3 cable through the kickpipe and stuffing tube, starting from the compartment below.

10. Prepare the cable end (Step 9) and insert through the terminal tube into the start-stop pushbutton.

11. Pack the terminal tube.

12. Take up the slack cable, passing the excess cable into the compartment below.

13. Pack the stuffing tube.

14. Install one-eared cable straps over the cable and secure tightly to the stanchion using machine screws inserted into the drilled and tapped holes (Step 5).

15. Install lugs and connect wires of the cable to the studs in the start-stop pushbutton, as shown on the elementary wiring diagram of Drawing 7.

16. Assemble the start-stop pushbutton.

JOB 6. Install a controller and start-stop pushbutton for a gasoline pump, a submersible pump outlet, and associated wiring in the C.P.O. Quarters.

Procedure:

1. Nipple the start-stop pushbutton to the bottom of the controller.

2. Select location and install the controller and pushbutton assembly on pads and brackets on the inboard side of the after bulkhead.

3. Install the single receptacle on pads on the outboard side of the forward bulkhead.

4. Select location, spot, center punch and have the after end of the inboard bulkhead drilled for a bushing for a THFA-4 cable.

5. Select location, spot, center punch and have the forward end of the inboard bulkhead drilled for a bushing for an FHFA-4 cable.

6. Install bushings in the holes in the inboard bulkhead (Steps 4 and 5).

7. Figure the run of cable from the bushing in the after bulkhead to the receptacle, along the overhead and the forward bulkhead.

8. Figure the run of cable from the forward bushing in the inboard bulkhead to the receptacle, along the forward bulkhead.

9. Figure the run of cable from the kickpipe in the overhead to the controller, along the overhead and after bulkhead.

10. Figure the run of cable from the after bushing in the inboard bulkhead to the controller, along the after bulkhead.

11. Figure the run of cable from the controller to the gasoline pump motor, along the after bulkhead.

12. Spot locations and have pads for one-eared cable straps welded to the forward and after bulkheads and the overhead, along the runs figured in Steps 7, 8, 9, 10 and 11.

13. Spot and mark positions on the receptacle and the controller where the cables will penetrate.

14. Remove the receptacle and the controller, drill, tap and insert terminal tubes for the required number and sizes of cables, in the locations determined in Step 13.

15. Reinstall the receptacle and the controller.

16. Pick up the cable at the bushing in the after bulkhead and run it toward the receptacle.

17. Install one-eared cable straps over the cable (Step 16) and secure loosely to the pads on the overhead and the forward bulkhead.

18. Determine the actual length of cable required to complete the cable run (Step 16) to the receptacle. Cut off the excess cable.

19. Prepare the cable end (Step 18) and install through a terminal tube into the receptacle.

20. Pull an FHFA-4 cable through the forward bushing in the inboard bulkhead, starting from the adjacent compartment. Run this cable toward the receptacle.

21. Install one-eared cable straps over the cable (Step 20) and secure loosely to the pads on the forward bulkhead.

22. Prepare the cable end (Step 20) and insert through the remaining terminal tube into the receptacle.

23. Take up the slack cable (Step 20) passing the excess cable through the bushing into the adjacent compartment.

24. Pick up the cable at the kickpipe in the overhead and run toward the controller.

25. Install one-eared cable straps over the cable (Step 24) and secure loosely to the pads on the overhead and the after bulkhead.

26. Determine the actual length of cable required to complete the cable run (Step 24) to the controller. Cut off the excess cable.

27. Prepare the cable end (Step 26) and install through a terminal tube into the controller.

28. Pull a THFA-4 cable through the after bushing in the inboard bulkhead, starting from the adjacent compartment. Run this cable toward the controller.

29. Install one-eared cable straps over the cable (Step 28) and secure loosely to the pads on the after bulkhead.

30. Prepare the cable end (Step 28) and insert through a terminal tube into the controller.

31. Take up the slack cable (Step 28), passing the excess through the bushing into the adjacent compartment.

32. Prepare the end of a THFA-4 cable and insert through the remaining terminal tube into the controller. Run this cable toward the motor.

33. Install one-eared cable straps over the cable (Step 32) from the controller to the motor and secure loosely to the pads.

34. Determine the actual length of cable required to complete the cable run (Step 32) to the motor, allowing sufficient slack (at the motor) for vibration of the motor. Cut off the excess cable.

35. Prepare the cable end (Step 34) and insert through the terminal tube provided on the terminal box of the motor.

36. Pack all terminal tubes.

37. Tighten all cable straps.

38. Install lugs and connect wires of the cables to the studs in the motor terminal box, controller and the single receptacle as shown on the elementary wiring diagram of Drawing 7.

39. Assemble the motor terminal box, controller and the receptacle.

JOB 7. Install a controller for a vent set, a submersible pump outlet, a four circuit distribution panel and associated wiring in the Crew's Quarters.

Procedure:

1. Select location and install the controller on pads on the outboard side of the after bulkhead.

2. Select location and install the power panel on "U" brackets on the forward bulkhead, midway between the inboard and outboard bulkheads.

3. Select location and install the single receptacle on pads on the forward end of the inboard bulkhead.

4. Select location, midway between the inboard and outboard bulkhead, and have the forward bulkhead drilled for a stuffing tube for a THFA-9 cable.

5. Install a stuffing tube in the hole in the inboard bulkhead (Step 4), starting from the forward compartment.

6. Figure the run of cable from the after bushing in the inboard bulkhead to the distribution panel, along the after bulkhead, overhead and the forward bulkhead.

7. Figure the run of cable from the bushing in the after bulkhead to the distribution panel.

   Note: This cable is to be run along the overhead and forward bulkhead along with the cable (side by side) figured in Step 6.

8. Figure the run of cable from the controller to the distribution panel.

   Note: This cable is to be run along the overhead and forward bulkhead along with the cables (side by side) figured in Steps 6 and 7.

9. Figure the run of cable from the forward bushing in the inboard bulkhead to the single receptacle.

10. Figure the run of cable from the single receptacle to the distribution panel along the inboard and forward bulkheads.

    Note: This cable is to be run on the inboard bulkhead side by side with the cable figured in Step 9 and on the forward bulkhead (from the overhead to the distribution panel) side by side with the cables figured in Steps 6, 7 and 8.

11. Figure the run of cable from the stuffing tube in the forward bulkhead to the distribution panel.

    Note: This cable is to be run side by side with the cables figured in Steps 6, 7, 8 and 10 from the overhead to the distribution panel.

12. Figure the run of cable from the controller to the vent motor, along the overhead and the after bulkhead.

13. Spot locations and have pads for one-eared cable straps welded to the forward and after bulkheads from the branching off points to the receptacle, controller and the after bushing in the inboard bulkhead, along the runs figured in Steps 6, 8, 10 and 12.

14. Spot locations and have pads for two-eared cable straps welded to the forward and inboard bulkheads and the overhead, along the runs figured in Steps 6 to 11, inclusive.

15. Have a pad welded to the inboard bulkhead, close to the receptacle, for the ground connection.

16. Spot and mark positions on the bottom of the distribution panel, on the side of the controller and ends of the receptacle, where cables will penetrate.

    Note: Location where the ground cable will penetrate the receptacle should also be marked.

17. Remove the distribution panel, controller and the receptacle, drill and insert cable clamps for the required number and sizes of cables, in the locations determined in Step 16.

18. Reinstall the distribution panel, controller and the snap switch.

19. Pick up the cable at the bushing in the after bulkhead and run it toward the distribution panel.

20. Install two-eared cable straps over the cable (Step 19) and secure loosely to the pads on the overhead and forward bulkheads.

21. Pick up the cable at the after bushing in the inboard bulkhead and pull it through the two-eared cable straps (Step 20) from the after bulkhead to the distribution panel.

22. Install one-eared cable straps over the cable (Step 21) from the inboard bulkhead and the branching-off point and secure loosely to the pads on the after bulkhead.

23. Prepare the end of a THFA-4 cable and insert through a cable clamp into the controller and tighten the cable clamp. Pull this cable through the two-eared cable straps (Step 20) from the after bulkhead to the distribution panel.

24. Determine the actual lengths of cable required to complete the cable runs (Steps 19, 21 and 23). Cut off the excess cable.

25. Prepare the ends of the cables (Step 24) and insert through the cable clamps into the distribution panel. Tighten the cable clamps.

26. Pick up the cable at the forward bushing in the inboard bulkhead and run it toward the receptacle.

27. Prepare the cable end (Step 26) and insert through a cable clamp into the receptacle. Tighten the cable clamp.

28. Install two-eared cable straps over the cable (Step 26) and secure loosely to the pads on the inboard bulkhead.

29. Prepare the end of a THFA-4 cable and insert through a cable clamp into the receptacle and tighten the cable clamp. Pull this cable through the two-eared cable straps on the inboard bulkhead (Step 28) and the forward bulkhead (Step 20) to the distribution panel.

30. Install one-eared cable straps over the cable (Step 29) and secure loosely to the pads on the forward bulkhead.

31. Determine the actual length of cable required to complete the cable run (Step 29). Cut off the excess cable.

32. Prepare the cable end (Step 31) and insert through a cable clamp into the distribution panel. Tighten the cable clamp.

33. Pull a THFA-9 cable through the stuffing tube in the forward bulkhead, starting in the forward compartment. Pull this cable through the two-eared cable straps on the forward bulkhead (Step 20) to the distribution panel

34. Determine the actual length of cable required to complete the cable run (Step 33). Cut off the excess cable.

35. Prepare the cable end (Step 34) and insert through the remaining cable clamp into the distribution panel. Tighten the cable clamp.

36. Prepare the end of a THFA-4 cable and insert through the remaining cable clamp into the controller. Run this cable toward the motor.

37. Install one-eared cable straps over the cable (Step 36) from the controller to the motor and secure loosely to the pads.

38. Determine the actual length of cable required to complete the cable run (Step 36) to the motor, allowing sufficient slack (at the motor) for vibration of the motor. Cut off the excess cable.

39. Prepare the cable end (Step 38) and insert through the cable clamp provided on the terminal box of the motor.

40. Prepare the end of an SHFA-4 cable and insert through the remaining cable clamp into the receptacle and tighten the cable clamp. Run this cable toward the ground pad.

41. Determine the actual length of cable required to complete the cable run to the ground pad. Cut off the excess cable.

42. Pack the stuffing tube in the forward bulkhead.

43. Tighten all the cable straps.

44. Install lugs and connect wires of the cables to the studs on the motor terminal box, controller, distribution panel, single receptacle and the ground pad as shown on the elementary wiring diagram of Drawing 7.

45. Assemble the motor terminal box, controller, distribution panel and the single receptacle.

JOB 8. Install power system wiring in the Engine Room and connect to 440 volt, 3 phase, 60 cycle supply.

Procedure:

1. Figure the run of cable along the inboard and after bulkhead from the stuffing tube in the forward bulkhead to the main switchboard.

2. Figure the run of cable from the stuffing tube in the after bulkhead to the main switchboard.

3. Spot locations and have pads for one-eared cable straps welded to the inboard and after bulkheads, along the runs figured in Steps 1 and 2.

4. Pick up the cable at the forward bulkhead and run it toward the main switchboard.

5. Install one-eared cable straps over the cable (Step 4) from the forward bulkhead to the main switchboard and secure loosely to the pads.

6. Pick up the cable at the after bulkhead and run it toward the main switchboard.

7. Install one-eared cable straps over the cable (Step 6) from the after bulkhead to the main switchboard and secure loosely to the pads.

8. Determine the actual lengths of cable required to complete the cable runs to the switchboard. Cut off the excess cable.

9. Tighten all cable straps (Steps 5 and 7).

10. Prepare the cable ends, install lugs and secure to switches on the main switchboard as shown on the elementary wiring diagram of Drawing 7.

11. Install 10-ampere fuses in the feeder distribution box, controllers and the distribution panel.

12. Install 30-ampere fuses in the switches on the main switchboard.

13. Assist trainees (on other jobs) to complete and test all power system installations.

RUNNING, ANCHOR, AND SIGNAL LIGHT SYSTEM

MARINE ELECTRICAL DRAWINGS 8A AND 8B

Trainees should have sufficient knowledge of all the processes and blueprint reading before undertaking the work shown on Drawings 8A and 8B as well as the subsequent Drawing 9.

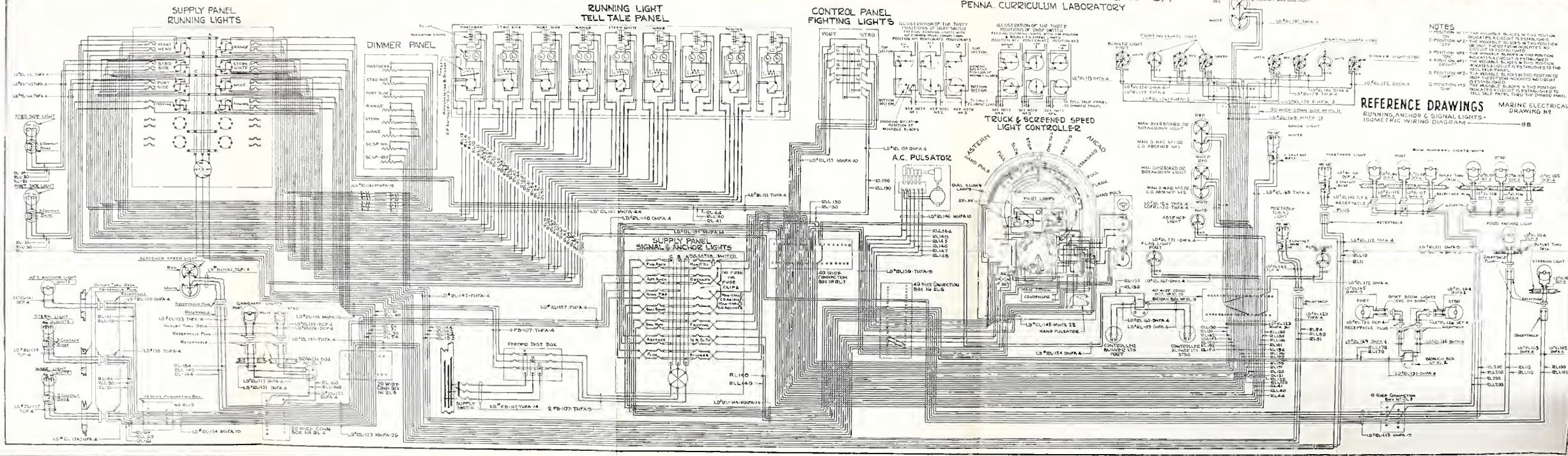
The required knowledge is gained by experiences in each of the processes and by participating in the installation of the Power, Lighting and Interior Communication systems illustrated and outlined in this book.

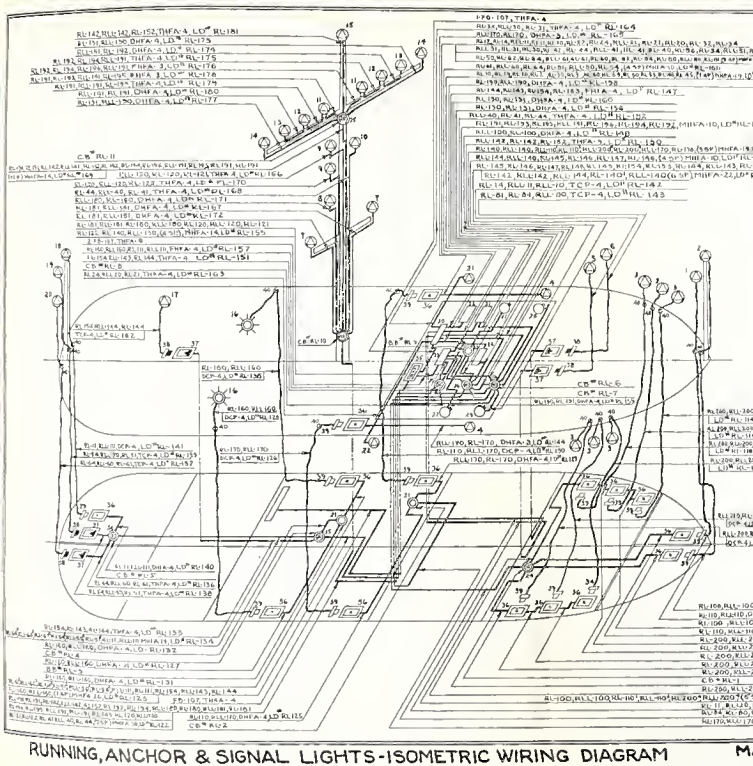
Trainees who are qualified, as noted above, should undertake this installation only under the careful supervision of the instructor.

RUNNING, ANCHOR & SIGNAL LIGHTS — ELEM. WIRING DIAGRAM

MARINE ELECTRICAL DRAWING Nº 8A

PENNA. CURRICULUM LABORATORY


SUPPLY PANEL
RUNNING LIGHTS
DIMMER PANEL
RUNNING LIGHT
TELL TALE PANEL
CONTROL PANEL
FIGHTING LIGHTS
SUPPLY PANEL
SIGNAL - ANCHOR LIGHTS
A.C. PULSATOR
TRUCK & SCREENED SPEED
LIGHT CONTROLLER
ASTERN
AHEAD
FULL
HALF
SLOW
STOP
ONE TWO
STANDARD
HAND PULS
PILOT LAMPS
RELAY
DIAL KNOWN LAMPS
MASTHEAD
STBD SIDE
PORT SIDE
RANGE
STERN WHITE
WAKE
TOWING
STERN LIGHT
STEM SIDE LIGHT
PORT SIDE LIGHT
SCREENED SPEED LIGHT
ANT. ANCHOR LIGHT
GANGWAY LIGHTS
RECEPTACLE PLUG
SCRATCH BOX NO 2
10 WIRE CONNECTION BOX NR EL-3
20 WIRE CONN BOX NR EL-4
40 WIRE CONNECTION BOX NR EL-7
40 WIRE CONNECTION BOX NR EL-8
RECORD DIST BOX
SUPPLY SWITCH
NO FUSE OR FUSE CLIPS
COMBINATION CO ABSENCE
MAN O WAR NT & OC
MAN OVERBOARD OC
BITEADOWN LIGHT
MAN O WAR NT & OC ABSENCE NR 1
MAN O WAR NT & OC ABSENCE NR 2
MAN OVERBOARD OC BITEADOWN LIGHT
ANCHOR LIGHT
FLAG LIGHT PORT
FLAG LIGHT STBD
MASTHEAD LIGHT
PORT
STBD
BOW NUMERAL LIGHTS WHITE
PORT RUNG & ANCHOR WARNING LIGHT
RUNNING LIGHTS STBD
DIMMER LIGHT STBD
BLINKER LIGHT
LIGHT NO LIGHTS TIGHT
RANGE LIGHT
3 CONTACT BASE
MASTHEAD LIGHT
PORT
STBD
BOW NUMERAL LIGHTS WHITE
PORTABLE TOWING LIGHT
RECEPTACLE
PLUG
GANGWAY LIGHTS PORT
GANGWAY LIGHTS STBD
RECEPTACLE PLUG
SCRATCH BOX NO 2
10 WIRE CONNECTION BOX NR EL-5
POOP ANCHOR LIGHT
STERN LIGHT
RECEPTACLE
OUTLET THRU DECK
CHAT BOOM LIGHTS (EMC ON BOOM)
PORT
STBD
RECEPTACLE PLUG
SCRATCH BOX NO 2
10 WIRE CONNECTION BOX NR EL-6
ILLUSTRATION OF THE THREE POSITIONS OF SNAP SWITCH
ILLUSTRATION OF THE THREE POSITIONS OF SNAP SWITCH
TOP SECTION
BOTTOM SECTION
SHOWING ROTATION POSITION OF MOVABLE BLADES
SHOWING RELATIVE POSITION OF MOVABLE BLADES
TO SUPPLY FILAMENT LAMPS
TO TELL TALE PANEL TO DIMMER PANEL
POSITION NR 1
POSITION NR 2
POSITION NR 3
SEE NOTE NR 1
SEE NOTE NR 2
SEE NOTE NR 3
NOTES
1 POSITION NR 1 - THE MOVABLE BLADES IN THIS POSITION INDICATES A CIRCUIT IS ESTABLISHED TO TELL TALE PANEL THRU THE DIMMER PANEL.
2 POSITION NR 2 - THE MOVABLE BLADES IN THIS POSITION OR ONLY THREE FROM INDICATES NO CIRCUIT IS ESTABLISHED.
3 POSITION NR 3 - THE MOVABLE BLADES IN THIS POSITION INDICATES A CIRCUIT IS ESTABLISHED TO THE SUPPLY FILAMENT LAMPS.
4 POSITION NR 1 - THE MOVABLE BLADES IN THIS POSITION INDICATES A CIRCUIT IS ESTABLISHED TO TELL TALE PANEL THRU THE DIMMER PANEL.
5 POSITION NR 2 - THE MOVABLE BLADES IN THIS POSITION OR ONLY THREE FROM INDICATES NO CIRCUIT IS ESTABLISHED.
6 POSITION NR 3 - THE MOVABLE BLADES IN THIS POSITION INDICATES A CIRCUIT IS ESTABLISHED TO THE SUPPLY FILAMENT LAMPS.
REFERENCE DRAWINGS
RUNNING, ANCHOR & SIGNAL LIGHTS - ISOMETRIC WIRING DIAGRAM
MARINE ELECTRICAL DRAWING Nº 8B



BILL OF MATERIAL

SYMBOL	QTY. REQ'D	DESCRIPTION	NAVY STOCK NUMBER
	1	STEERING LIGHT, TYPE "AR"	9-5-3587-1
	2	FORD. ANCHOR LIGHT (END FIXTURE)	9-5-4631-1
	4	BOW NUMERAL LIGHT, TYPE "A"	6-5-3605-1
	4	BOAT BOOM LIGHT, TYPE "F"	9-5-4089-1
	6	MASTHEAD LIGHT, TYPE "AM"	9-5-4640-1
	1	PORTABLE TOWING LIGHT "RM"	"
	7	FLAG LIGHT, TYPE "G"	9-5-4637-1
	8	ABSENCE LIGHT	9-5-4926-1
	5	FOR PERSONNEL BREAKDOWN LIGHTS	"
	10	RANGE LIGHT, TYPE "RM"	9-5-4640-1
	11	FIGHTING LIGHT, GREEN	9-5-5241-1
	12	" RED	"
	13	" WHITE	"
	14	BLINKER LIGHT	9-5-4835-1
	15	FIRE TRUCK & AIRCRAFT WARNING LIGHT	9-5-3378-1
	16	GANGWAY LIGHT	9-5-4598-1
	17	SCREENED SPEED LIGHT, TYPE "CS"	9-5-4537-1
	18	ALT. ANCHOR LIGHT (RED AT), TYPE "L"	9-5-4537-1
	19	STERN LIGHT, TYPE "A"	9-5-3087-1
	20	WAKE LIGHT, TYPE "E"	9-5-4788-1
	21	PORT SIDE LIGHT, TYPE "RSP"	9-5-3633-1
	22	STBD. SIDE LIGHT, TYPE "RSS"	"
	23	BRANCH BOX, W.T. TYPE "EF"	9-5-4660-1
	24	CONN. BOX, W.T. 10 WIRE, TYPE "V"	9-5-5161-1
	25	CONN. BOX, 20 WIRE, W.T. TYPE "V"	9-5-4802-1
	26	CONN. BOX, 40 WIRE, W.T. TYPE "V"	9-5-4803-1
	27	CONTROLLER, RUNNING LIGHTS, TYPE "C"	9-5-4260-1
	28	TRUCK & SCREENED SPEED LIGHT CONT.	9-5-4670-1
	29	A.C. FULGATOR, TYPE "H"	9-5-5269-1
	30	SUPPLY PANEL, RUNNING LIGHTS, TYPE "A"	9-5-4792-1
	31	DIMMER PANEL	9-5-4806-1
	32	RUNNING LIGHT TELL-TALE PANEL	9-5-5181-1
	33	SUPPLY PANEL, SIGNAL & ANCHOR LIGHTS	9-5-4789-1
	34	CONTROL PANEL, FIGHTING LIGHTS	9-5-4345-1
	35	INDEX OUT BOX, 10 WIRE W.T.	9-5-4232-1
	36	RECEPTACLE, SINGLE, D.P. 10A, 125V., W.T.	15 9-5-4268-1
	37	RECEPTACLE, SINGLE, 10A, 250V., W.T., 3 PIN	5 9-5-4563-1
	38	PLUG, TYPE "C"	5 9-5-4787-1
	39	PLUG, TYPE "D"	15 9-5-4468-1
	40	OUTLET THROUGH DECK, TYPE "I"	15 9-5-4182-1
		OHPA-4 CABLE	250'
		OHPA-5 CABLE	55'
		THPA-8 CABLE	250'
		THPA-9 CABLE	85'
		CHPA-4 CABLE	25'
		OHTA-3 CABLE	30'
		THPA-3 CABLE	5'
		MHPA-10 CABLE	70'
		MHPA-14 CABLE	25'
		MHPA-19 CABLE	90'
		MHPA-22 CABLE	15'
		MHPA-26 CABLE	25'
		MHPA-30 CABLE	60'
		DCP-4 CABLE	250'
		TCP-4 CABLE	100'

REFERENCE DRAWINGS: MARINE ELECT. DRAWING No.

1. RUNNING, ANCHOR & SIGNAL LIGHTS ELEMENTARY WIRING DIAGRAM — 8A

NOTES:

1. FOR LOCATION OF LIGHTS SEE OUTBOARD PROFILE.
2. SIZE, TYPE & QUANTITY OF STUFFING TUBES, TERMINAL TUBES, BUSHINGS & CLAMPS TO BE DETERMINED BY TRAINEE.

RUNNING, ANCHOR & SIGNAL LIGHTS - ISOMETRIC WIRING DIAGRAM

MARINE ELECTRICAL DRAWING Nº 8B

COMBINED ELECTRICAL INSTALLATIONS

MARINE ELECTRICAL DRAWINGS 9, 10A, 10B and 10C

As a final test, the simultaneous installation of power, lighting and interior communication systems shown on Drawings 3 to 8, inclusive, may be accomplished.

The composite plan, Drawing 9, was developed for this purpose and drawings 10A, 10B and 10C were developed for main wireways and bulkhead drillings for such an installation.

The bulkhead drillings for main cable runs, Drawings 10B and 10C, are related to Drawing 10A by the section numbers and were developed by use of the "60-40 rule" explained in Unit 16, Page 101.

Branch wireways and associated bulkhead and deck drillings should be selected and determined by the trainee under direction of the instructor.

This combined installation will enable the trainee to coordinate his work and will give him experiences closely related to actual shipboard installations.

The following general procedure may be followed for step by step installation in any compartment.

(a) Determine locations of equipment to be mounted.

(b) Determine runs and arrangement of cable passing through the compartment, between equipments and from equipments through bulkheads or decks.

(c) Drill decks and/or bulkheads and beams and install stuffing tubes or bushings as required.

(d) Install wireways and manufacture cable straps.

(e) Pull in cable and secure in wireways or under cable straps.

(f) Determine cable entrance locations on equipment, drill, tap and install terminal tubes or drill and install cable clamps.

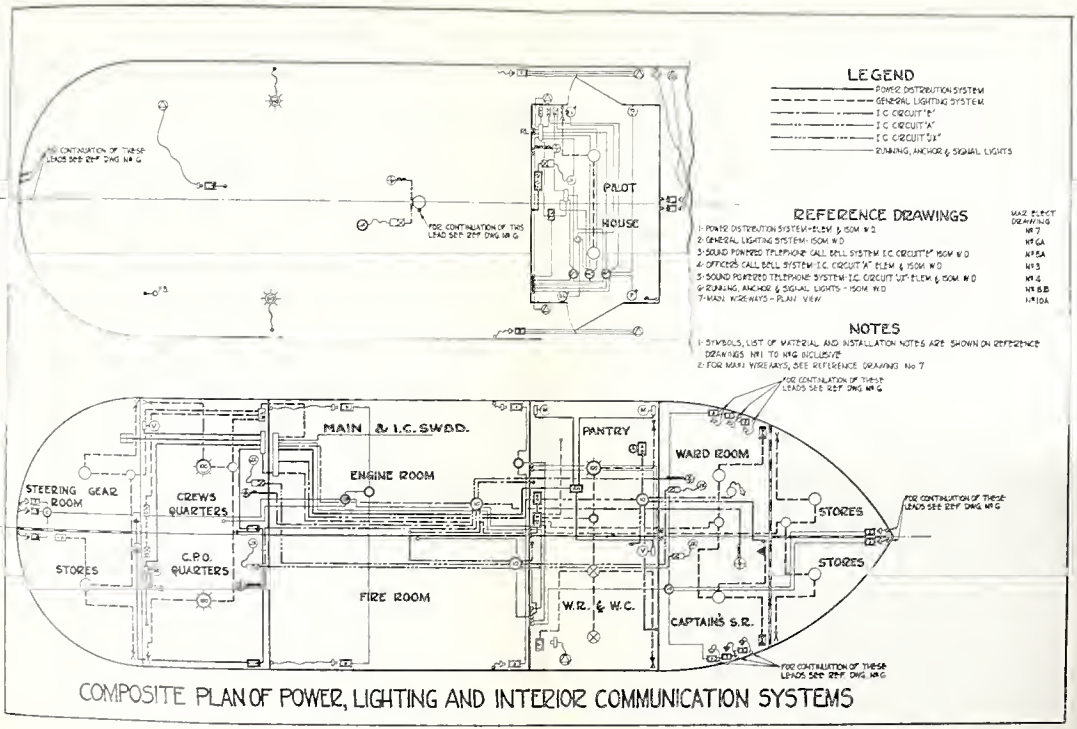
(g) Install equipment in locations determined in Step (a) above.

(h) Prepare cable ends and insert cable through terminal tubes or cable clamps into equipment.

(i) Pack stuffing tubes and terminal tubes.

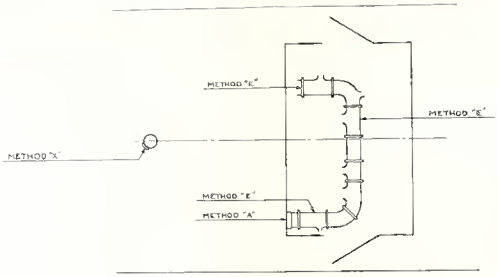
(j) Install lugs or terminals on conductors and connect inside the equipments.

(k) Test circuits for satisfactory operation.


LEGEND
POWER DISTRIBUTION SYSTEM
GENERAL LIGHTING SYSTEM
I.C. CIRCUIT "B"
I.C. CIRCUIT "A"
I.C. CIRCUIT "D"
RUNNING, ANCHOR & SIGNAL LIGHTS
REFERENCE DRAWINGS
MAR. ELECT. DRAWING
1- POWER DISTRIBUTION SYSTEM-ELEM. 6 150M W.D. No 7
2- GENERAL LIGHTING SYSTEM-150M W.D. No 6A
3- SOUND POWERED TELEPHONE CALL BELL SYSTEM I.C. CIRCUITS" 150M W.D. No 8A
4- OFFICERS CALL BELL SYSTEM I.C. CIRCUIT "A" ELEM. 6 150M W.D. No 3
5- SOUND POWERED TELEPHONE SYSTEM-I.C. CIRCUIT "D" ELEM. 6 150M W.D. No 6
6- RUNNING, ANCHOR & SIGNAL LIGHTS - 150M W.D. No 8B
7- MAIN WIREWAYS - PLAN VIEW No 10A
NOTES
1- SYMBOLS, LIST OF MATERIAL AND INSTALLATION NOTES ARE SHOWN ON REFERENCE DRAWINGS No 1 TO No 6 INCLUSIVE
2- FOR MAIN WIREWAYS, SEE REFERENCE DRAWING No 7
FOR CONTINUATION OF THESE LEADS SEE REF DWG No 6
PILOT HOUSE
MAIN & I.C. SWBD.
PANTRY
WARD ROOM
ENGINE ROOM
STEERING GEAR ROOM
CREWS QUARTERS
STORES
C.P.O. QUARTERS
FIRE ROOM
W.R. & W.C.
CAPTAIN'S S.R.
STORES
STORES

COMPOSITE PLAN OF POWER, LIGHTING AND INTERIOR COMMUNICATION SYSTEMS

MARINE ELECTRICAL DRAWING No 9



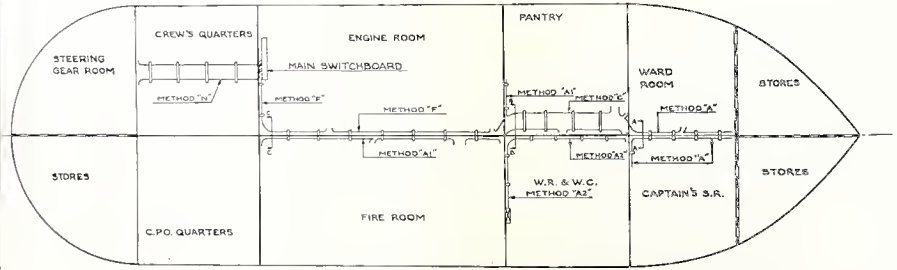
REFERENCE DRAWINGS:

MARINE ELECT. DRAWING

1- COMPOSITE PLAN OF POWER, LIGHTING & INTERIOR COMMUNICATION SYSTEMS ------ 9
2- BULKHEAD & DECK DRILLINGS ------ 10B & 10C

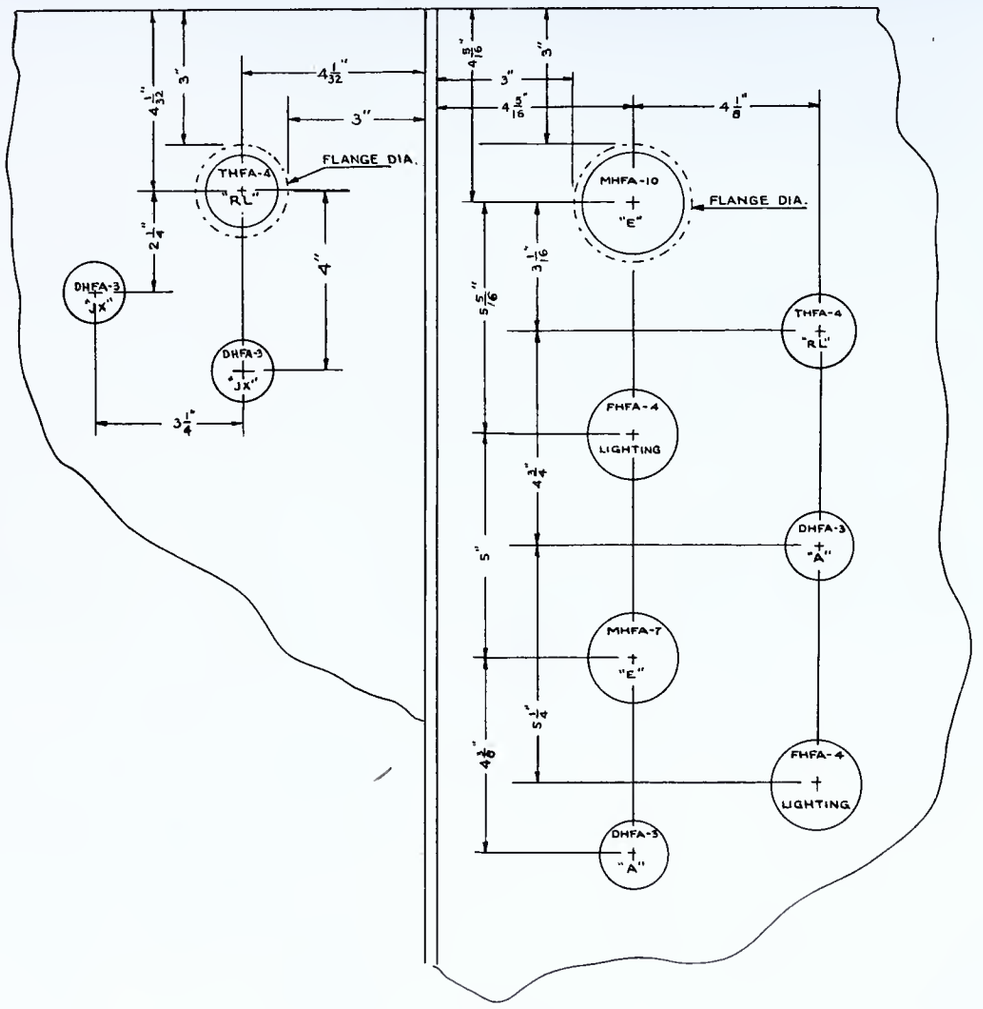
NOTES:

1- THIS DRAWING TO BE USED IN CONJUNCTION WITH DRAWING Nº 9
2- BULKHEAD AND DECK DRILLINGS FOR MAIN CABLE RUNS SHOWN ON DRAWINGS Nºs. 10B & 10C

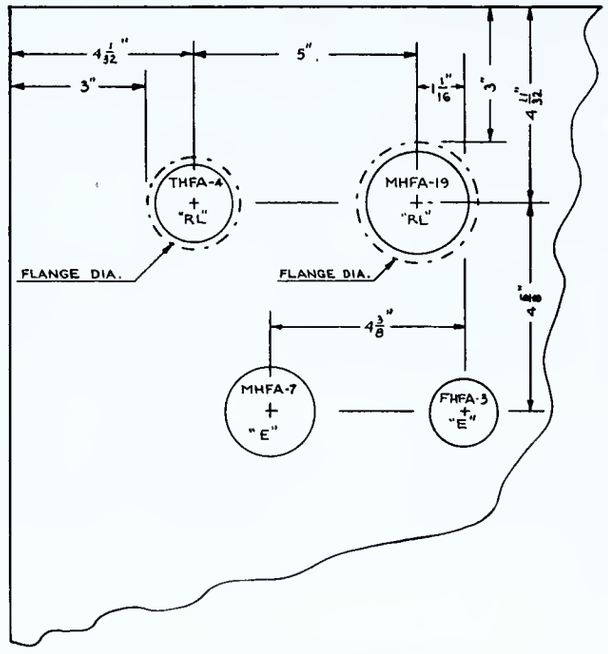


MAIN WIREWAYS - PLAN VIEW

SECTION "AA"



SECTION "CC"



REFERENCE DRAWING:

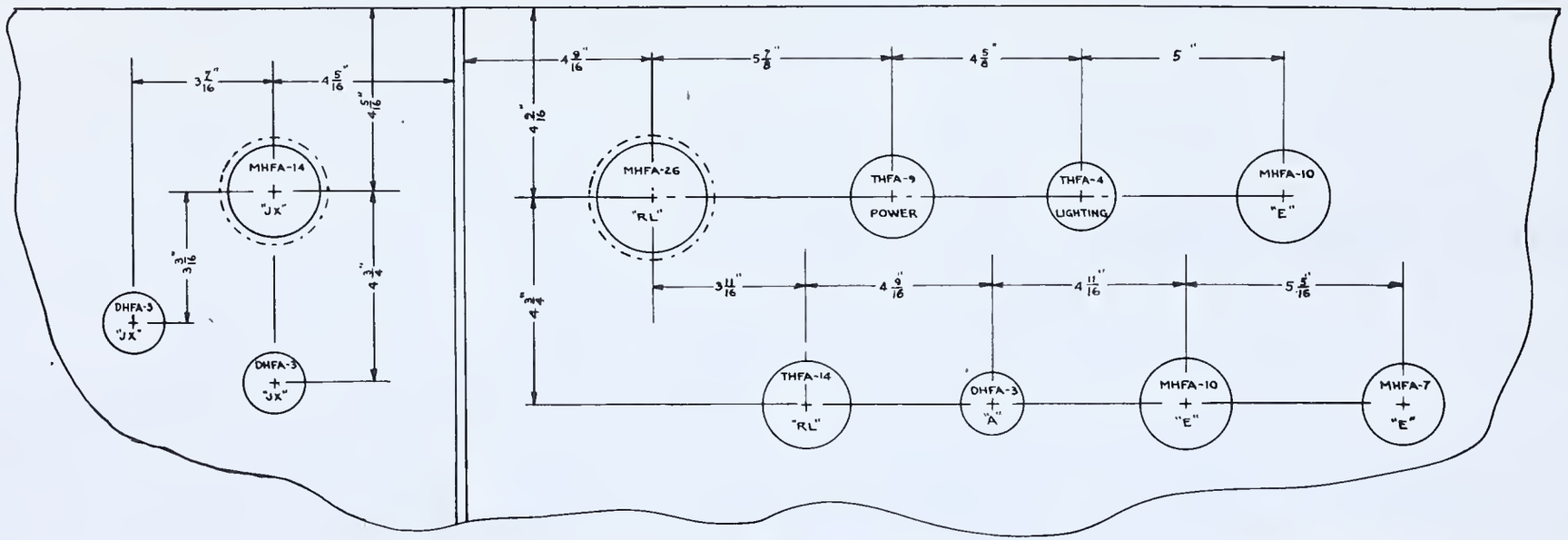
1- MAIN WIREWAYS - PLAN VIEW

MARINE ELECT. DRAWING 10A

BULKHEAD DRILLINGS

MARINE ELECTRICAL DRAWING Nº10B

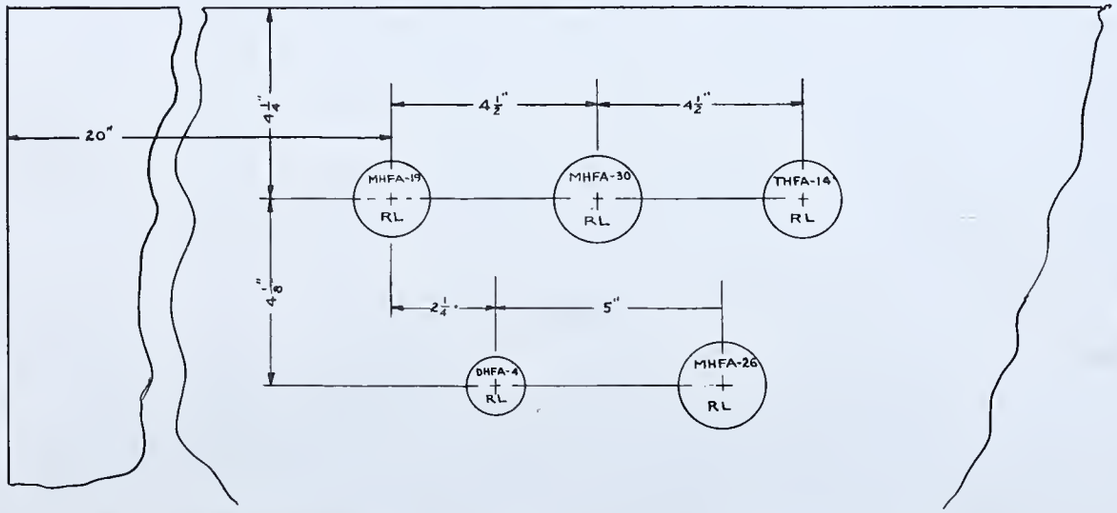
SECTION "B B"



DECK DRILLING - PILOT HOUSE - STBD. SIDE

REFERENCE DWG:
1 - MAIN WIREWAYS - PLAN VIEW

MARINE ELECT. DR. Nº 10A



BULKHEAD AND DECK DRILLINGS

MARINE ELECTRICAL DRAWING Nº 10C

GLOSSARIES

A. LIST OF DRAWING SYMBOLS Page 344

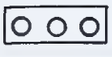
B. SHIPBUILDING TERMS Page 354

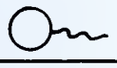
C. ELECTRIC TERMS AND ABBREVIATIONS Page 364

SYMBOL LIST FOR MARINE ELECTRICAL INSTALLATION

SYMBOL	DESCRIPTION
	AMMUNITION HOIST FIXTURE
	BATTLE LANTERN
	BEDSIDE PORTABLE
	BERTH FIXTURE
	BULKHEAD FIXTURE, W.T., NO GUARD, NO SWITCH, DIFFUSING GLOBE
	BULKHEAD FIXTURE, W.T., NO GUARD, WITH SWITCH, DIFFUSING GLOBE
	BULKHEAD FIXTURE, W.T., NO GUARD, NO SWITCH, DIFFUSING GLOBE, WITH SHIELD
	BULKHEAD FIXTURE, W.T., NO GUARD, WITH SWITCH, DIFFUSING GLOBE, WITH SHIELD
	BULKHEAD FIXTURE, W.T., WITH GUARD, NO SWITCH, DIFFUSING GLOBE
	BULKHEAD FIXTURE, W.T., WITH GUARD AND SWITCH, DIFFUSING GLOBE
	BULKHEAD FIXTURE, N.W.T., NO GUARD, WITH SWITCH, DIFFUSING GLOBE
	BULKHEAD FIXTURE, N.W.T., WITH GUARD, NO SWITCH, DIFFUSING GLOBE
	BULKHEAD FIXTURE, W.T., NO GUARD, NO SWITCH, BLUE GLOBE
	BULKHEAD FIXTURE, W.T., NO GUARD, WITH SWITCH, BLUE GLOBE
	BULKHEAD FIXTURE, N.W.T., NO GUARD, NO SWITCH, BLUE GLOBE
	BULKHEAD FIXTURE, N.W.T., NO GUARD, WITH SWITCH, BLUE GLOBE
	CEILING FIXTURE, EXPLOSION PROOF
	CEILING FIXTURE, N.W.T., NO GUARD
	CEILING FIXTURE, N.W.T., WITH GUARD
	CEILING FIXTURE, N.W.T., WITH REFLECTOR
	CEILING FIXTURE, N.W.T., WITH SHIELD
	CEILING UNIT, N.W.T.
	CEILING UNIT, N.W.T.
	CEILING UNIT, N.W.T.

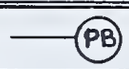
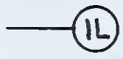
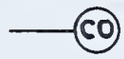
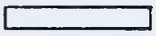
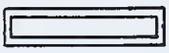
SYMBOL	DESCRIPTION
	DECK FIXTURE, W.T., NO GUARD, NO SWITCH, DIFFUSING GLOBE
	DECK FIXTURE, W.T., NO GUARD, WITH SWITCH, DIFFUSING GLOBE
	DECK FIXTURE, W.T., NO GUARD, NO SWITCH, DIFFUSING GLOBE, WITH SHIELD
	DECK FIXTURE, W.T., NO GUARD, WITH SWITCH, DIFFUSING GLOBE, WITH SHIELD
	DECK FIXTURE, W.T., WITH GUARD, NO SWITCH, DIFFUSING GLOBE
	DECK FIXTURE, W.T., WITH GUARD AND SWITCH, DIFFUSING GLOBE
	DECK FIXTURE, W.T., NO GUARD OR DIFFUSING GLOBE, WITH REFLECTOR
	DECK FIXTURE, W.T., NO GUARD, NO SWITCH, BLUE GLOBE
	DECK FIXTURE, W.T., NO GUARD, WITH SWITCH, BLUE GLOBE
	DECK FIXTURE, N.W.T., NO GUARD, NO SWITCH, BLUE GLOBE
	DECK FIXTURE, N.W.T., NO GUARD, WITH SWITCH, BLUE GLOBE
	DESK FIXTURE
	MAGAZINE FIXTURE, 6v., 32 C.P., W.T.
	FLOOD LIGHT
	GASOLINE COMPARTMENT LIGHT
	HAND LANTERN
	HANGER FIXTURE
	MAGAZINE FIXTURE, W.T.
	PORTABLE, N.W.T.
	PORTABLE LIGHT, W.T.
	PRESSURE PROOF FIXTURE
	SHADED LIGHT
	TURRET FIXTURE
	TURRET FIXTURE
	WATER COLUMN LIGHT
	100 WATT UNIT-W.T.
	200 WATT UNIT-N.W.T.

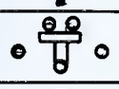
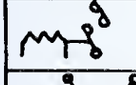
SYMBOL	DESCRIPTION
	200 WATT UNIT-W.T.
	BRACKET FAN
	PORTABLE VENT. SET
	RADIANT HEATER
	HEATER
	BELL (CIRCUIT LETTER AND SIZE INSERTED)
	BUZZER (CIRCUIT LETTER INSERTED)
	MOTOR OPERATED HORN (CIRCUIT LETTER INSERTED)
	SIREN (CIRCUIT LETTER INSERTED)
	COMBINED TRANSMITTER AND INDICATOR (CIRCUIT LETTER INSERTED)
	INDICATOR (CIRCUIT LETTER INSERTED)
	TRANSMITTER (CIRCUIT LETTER INSERTED)
	CONTACT MAKER (CIRCUIT LETTER INSERTED)
	MOTOR CONTACT MAKER (CIRCUIT LETTER INSERTED)
	THERMOSTAT - WITHOUT RESISTOR
	THERMOSTAT - WITH RESISTOR
	TRANSFORMER
	LIGHTNING ARRESTOR
	SOLENOID
	VOICE TUBE OUTLET
	ANNUNCIATOR (CIRCUIT LETTER AND NUMBER OF DROPS INSERTED)
	INDICATOR-LAMP TYPE - ONE DIAL
	INDICATOR-LAMP TYPE - TWO DIAL
	INDICATOR-LAMP TYPE - THREE DIAL
	INDICATOR-LAMP TYPE - FOUR DIAL
	INDICATOR-LAMP TYPE - SIX DIAL
	PUSH BUTTON, PEAR SINGLE, N.W.T.

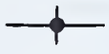
SYMBOL	DESCRIPTION
	PUSH BUTTON, PEAR DOUBLE, N.W.T.
	PUSH BUTTON, PEAR TRIPLE, N.W.T.
	PUSH BUTTON, SINGLE N.W.T.
	PUSH BUTTON, SINGLE W.T.
	PUSH BUTTON DOUBLE W.T.
	PUSH BUTTON, TRIPLE W.T.
	PUSH BUTTON, 4 GANG W.T.
	PUSH BUTTON, 5 GANG W.T.
	GENERAL ANNOUNCING TELEPHONE TRANSMITTER
	GENERAL ANNOUNCING TELEPHONE REPRODUCER
	SHIP SERVICE TELEPHONE, AUTOMATIC OR MANUAL
	SOUND POWERED TELEPHONE HANDSET IN W.T. BOX (CIRCUIT LETTER INSERTED)
	SOUND POWERED TELEPHONE HANDSET (CIRCUIT LETTER INSERTED)
	SELECTIVE SWITCH USED ON SOUND POWERED TEL. CIRCUIT.
	SOUND POWERED BATTLE TELEPHONE SWITCH BOX W.T. (NUMBER OF SWITCHES INSERTED)
	JACK BOX USED ON SOUND POWERED TELEPHONE CIRCUIT
	JACK BOX USED ON SOUND POWERED TELEPHONE CIRCUIT, 2 GANG
	JACK BOX USED ON SOUND POWERED TELEPHONE CIRCUIT, 4 GANG
	BRANCH BOX N.W.T.
	BRANCH BOX W.T.
	BRANCH JUNCTION BOX W.T.
	CONNECTION BOX N.W.T. (SIZE IN WIRES AS SPECIFIED)
	CONNECTION BOX W.T. (SIZE IN WIRES AS SPECIFIED)
	CONNECTION BOX W.T. TELEPHONE SERVICE (SIZE IN PAIRS OF WIRES AS SPECIFIED)
	COUPLING MULTIPLE POINT (NUMBER OF POINTS AS SPECIFIED)
	DISTRIBUTION BOX NO SWS., MIDGET FUSES N.W.T., SINGLE PHASE BRANCH (SIZE AS SPEC.)
	DISTRIBUTION BOX NO SWS., MIDGET FUSES, W.T., SINGLE PHASE BRANCH (SIZE AS SPEC.)

SYMBOL	DESCRIPTION
4T	DIST. BOX SWS. INTERLOCKING FUSE COVER, W.T. SINGLE PHASE BRANCH (SIZE AS SPECIFIED)
4T	DIST. BOX WITH SWS., MIDGET FUSES, N.W.T., SINGLE PHASE BRANCHES (SIZE AS SPECIFIED)
4T	DIST. BOX WITH SWS., MIDGET FUSES, W.T., SINGLE PHASE BRANCHES (SIZE AS SPECIFIED)
A	FEEDER CONNECTION BOX W.T.
4F	FEEDER DISTRIBUTION BOX, N.W.T., 0-30a FUSES (SIZE AS SPECIFIED)
4F	FEEDER DISTRIBUTION BOX, W.T., 0-30a FUSES (SIZE AS SPECIFIED)
4K	FEEDER DIST. BOX N.W.T., 30a FUSES - 250v. 3-PHASE MAINS (SIZES AS SPECIFIED)
4K	FEEDER DIST. BOX W.T., 30a FUSES - 250v. 3-PHASE MAINS (SIZES AS SPECIFIED)
R	FEEDER JUNCTION BOX, N.W.T., 0-30a FUSES, 31-60a FUSES, 250v. 3-PHASE MAIN
R	FEEDER JUNCTION BOX, W.T., 0-30a FUSES, 31-60a FUSES, 250v. 3-PHASE MAIN
S.C.	SHORE CONNECTION BOX, W.T.
S.T.	SHORE TERMINAL BOX, W.T.
S.C.T.	SHORE CONNECTION AND TERMINAL BOX, N.W.T.
	OUTLET-ARC WELDING
	PLUG COMMERCIAL TYPE
	PLUG RECEPTACLE
	RECEPTACLE, SINGLE, D.P. 10a, 125v. - N.W.T.
	RECEPTACLE, SINGLE, D.P., 10a, 125v - W.T.
	RECEPTACLE, SINGLE, 10a, 500v. N.W.T. 3 PHASE
	RECEPTACLE, SINGLE, 10a, 500v. W.T. 3 PHASE
	RECEPTACLE, SINGLE 10a, 500v. - N.W.T. 3 PHASE, GROUNDED
	RECEPTACLE, SINGLE 10a, 500v. - W.T. 3 PHASE, GROUNDED
	RECEPTACLE DOUBLE, D.P., 10a, 125v. N.W.T.
	RECEPTACLE DOUBLE, D.P., 10a, 125v. W.T.
	RECEPTACLE, DOUBLE, D.P., 10a, 125v. N.W.T.
	RECEPTACLE, SINGLE, D.P., 10a, 125v. N.W.T. CONVENIENCE
	SWITCH, SNAP, 10a, D.P.S.T., - N.W.T.

SYMBOL	DESCRIPTION
	SWITCH, SNAP 10a, D.P.S.T. - W.T.
	SWITCH, TOGGLE S.P. - N.W.T.
	SWITCH, SNAP, 25a, 250v. D.P.S.T. - W.T.
	SWITCH, DOOR OPERATED D.P.
	SWITCH, DOOR OPERATED S.P.
	SWITCH, WITH INDICATOR, W.T.
	SWITCH, SNAP, 10a, D.P.D.T.
	SWITCH AND RECEPTACLE, SINGLE, D.P., 10a 125v., N.W.T.
	SWITCH AND RECEPTACLE, SINGLE, D.P., 10a 125v., W.T.
	SWITCH AND RECEPTACLE, SINGLE, 25a, 500v., W.T., INTERLOCKING - 3 PHASE GROUNDED
	SWITCH AND RECEPTACLE, DOUBLE, D.P., 10a, 125v., N.W.T.
	SWITCH AND RECEPTACLE, DOUBLE, D.P., 10a, 125v., W.T.
	AUTOMATIC BUS TRANSFER EQUIPMENT - N.W.T.
	CONTROL PANEL FOR FIGHTING LIGHTS, W.T.
	BLINKER LIGHT CONTROLLER
	TRUCK AND SCREENED SPEED LIGHT CONTROLLER
	PULSATOR FOR TRUCK AND SCREENED LIGHTS
	VENT SET
	STOWAGE BATTERY
	TRANSFORMER
	GENERATOR
	MOTOR
	MOTOR GENERATOR
	EXCITER
	RHEOSTAT
	MOTOR CONTROLLER - L.V.R. (LOW VOLTAGE RELEASE)
	MOTOR CONTROLLER - L.V.P. (LOW VOLTAGE PROTECTION)

SYMBOL	DESCRIPTION
	PUSHBUTTON (MASTER CONTROLLER)
	INDICATOR LIGHT GENERAL
	INDICATOR LIGHT (CURRENT - ON)
	MOTOR CONTROLLER
	SWITCHBOARD OR PANEL, N.W.T.
	SWITCHBOARD OR PANEL, W.T.

ADDITIONAL SYMBOLS TO BE USED ON ELEMENTARY WIRING DIAGRAMS	
SYMBOL	DESCRIPTION
	AUTOMATIC QUENCHBREAK SWITCH TYPE - AQB
	CARBON CIRCUIT-BREAKER TYPE - ACB
	FUSED SWITCH SINGLE THROW
	UNFUSED SWITCH SINGLE THROW
	FUSED
	OVERLOAD COIL (TIME LAY) TO BE ADDED TO CIRCUIT BREAKER, CONTRACTOR OR SWITCH CONTROL
	RESISTOR
	RESISTOR, VARIABLE
	MERCURY ARC RECTIFIER
	BELL
	BUZZER
	LAMP
	INDICATOR LAMP (COLOR AS SPECIFIED)
	INSTRUMENT SWITCH TYPE - J (CONTACTS AND CIRCUIT CONTROL AS SHOWN)
	D.C. AMMETER SHUNT
	CONTROL SWITCH (NUMBER OF CONTACTS AND SWITCH ARRANGEMENT AS SHOWN)
	RHEOSTAT
	CONTACTOR (CLOSING COIL CONTROL AS INDICATED)
	CONTACTOR MECHANICAL INTERLOCK (CLOSING COIL CONTROL AS INDICATED) (BUS TRANSFER EQUIPMENT)
	POLYPHASE TWO-WINDING TRANSFORMER
	AUTO - TRANSFORMER
	CURRENT TRANSFORMER
	POTENTIAL TRANSFORMER
	AMPERE - HOUR METER
	AMMETER

SYMBOL	DESCRIPTION
(F)	FREQUENCY METER
(REG)	GENERATOR VOLTAGE REGULATOR
(GD)	GROUND DETECTOR (ELECTROSTATIC)
(PF)	POWER-FACTOR METER
(WH)	WATTHOUR METER
(W)	WATTMETER
(S)	SYNCHROSCOPE
(V)	VOLTMETER
	CONDUCTORS, CROSSING BUT NOT CONNECTED
	CONDUCTORS, ELECTRICALLY CONNECTED
	BUS, WITH BRANCH
	CONDUCTORS WITH BRANCH
	GROUND CONNECTION
	THREE PHASE - DELTA (OR MESH)
	THREE PHASE - Y (OR STAR)
	THREE PHASE - Y (OR STAR) WITH NEUTRAL BROUGHT OUT AND GROUNDED
	THREE PHASE - T
	AUXILIARY CONTROL SWITCH TO BE ADDED TO CIRCUIT BREAKER OR SWITCH CONTROLLING AUXILIARY SWITCH CONTACTS; CONTACTS ON LEFT CLOSED WHEN SWITCH OR CIRCUIT BREAKER IS CLOSED. CONTACTS ON RIGHT OF VERTICAL LINE CLOSED WHEN SWITCH IS OPEN.

ADDITIONAL SYMBOLS TO BE USED ON ELEMENTARY WIRING DIAGRAMS	
SYMBOL	DESCRIPTION
	RELAY — CONTACTS PLACED ABOVE HORIZONTAL LINE OPEN AND CONTACTS BELOW LINE CLOSED WHEN RELAY IS DE-ENERGIZED AND VISE-VERSA
	RELAY FUNCTION DESIGNATION TO BE PLACED ALONGSIDE SYMBOL OUTLINED ABOVE
	OVER-CURRENT
	OVER-VOLTAGE
	OVER-POWER
	UNDER-CURRENT
	UNDER-VOLTAGE
	POWER DIRECTIONAL
	DIFFERENTIAL CURRENT
	DIFFERENTIAL POWER
	PILOT WIRE
	TEMPERATURE
	PHASE BALANCE CURRENT
	LOW VOLTAGE RELEASE AUTOMATIC RESTART
	LOW VOLTAGE PROTECTION
	RELAY TIME DESIGNATIONS
INST.	INSTANTANEOUS - NO TIME DELAY
I.T.	INVERSE TIME DELAY
D.T.	DEFINITE TIME DELAY

ABAFT--Toward the stern, aft.

ABEAM--At right angles to the keel.

ABOARD--On or in a ship.

AFT, AFTER--Near the stern.

AFTER PEAK--That space closest the stern, aft of the first transverse (aft) bulkhead.

ALOFT--In the top or upper rigging; on the yards, above the decks.

AMIDSHIP--In the vicinity of the middle portion of a vessel as distinguished from her ends. The term is used to convey the idea of general locality but not that of definite extent.

ANGLE, OR ANGLE BAR--A bar of angle-shaped section used as a stiffener and for attachment of one plate or shape to another.

ANGLE COLLAR--A collar or band made of an angle bar fitted tightly around a pipe, trunk, frame, longitudinal, or stiffener intersecting or projecting through a bulkhead or deck in order to make a watertight or oiltight joint.

ASTERN--Signifying position in the rear of or abaft the stern; as regards motion, the opposite of going ahead, backwards.

ATHWART, ATHWARTSHIP--In the transverse direction; from side to side at right angles to the fore-and-aft center line of a vessel.

AUXILIARIES--Various winches, pumps, motors, engines, etc., required on a ship, as distinguished from main propulsive machinery (boilers and engines on a steam installation).

BALLAST TANKS--Tanks provided in various parts of a ship for introduction of water ballast used to add weight to produce a change in trim or in stability of the ship.

BEAM--The extreme width of a ship. Also an athwartship or longitudinal member of the ship's frame supporting the deck.

BELOW--Underneath a deck or decks.

BETWEEN DECKS--The space between any two, not necessarily adjacent, decks. Frequently expressed as "'Tween Decks".

BILGE--The lowest portion of a ship inside the hull (below the inner bottom).

BINNACLE--A stand or case for housing a compass so that it may be conveniently consulted.

BOILER CASING--Walls forming a trunk leading from the boiler room to the boiler hatch which protect the different deck spaces from the heat of the boiler room, etc.

BOILER ROOM--A compartment in the hold, in the middle or after section of a vessel where the boilers are placed.

BOOBY HATCH--An access hatch from a weather deck protected by a hood from sea and weather. The hood is often fitted with a sliding cover to facilitate access.

BOOM--A term applied to a spar used in handling cargo, or as the lower piece of a fore-and-aft sail.

BOW--The forward end of the ship.

BRACKET--A steel plate, commonly with a reinforcing flange, used to connect two parts, such as deck beam to frame, frame to margin plate, etc.; also used to stiffen or tie beam angles to bulkheads, frames to longitudinals, etc.

BREADTH, REGISTERED--The distance amidship of greatest breadth to outside of plating.

BRIDGE--A high transverse platform often forming the top of a bridge house, extending from side to side of the ship. An enclosed space called the pilot house is erected on the bridge, in which are installed the navigating instruments such as the compass and binnacle, the control for the steering apparatus, and the signals to the engine room.

BRIDGE, NAVIGATING OR FLYING--The uppermost platform erected at the level of the top of the pilot house. It generally consists of a narrow walkway supported by stanchions, running from one side of the ship to the other, and the space over the top of the pilot house. A duplicate set of navigating instruments and controls for steering gear and engine room signals are installed on the flying bridge so that the ship may be navigated in good weather from this platform.

BULKHEAD--A term applied to any of the partition walls used for subdividing the interior of a ship into the various compartments. The main partition walls also serve as strength members of the ship's structure and as protection against water passing from one compartment to the other.

BULKHEAD, AFTER PEAK--The first transverse bulkhead forward of, or on, the stern post. This bulkhead forms the forward boundary of the after-peak tank and should be watertight.

BULKHEAD, CORRUGATED--A bulkhead made from plates of corrugated metal or by flat plates alternately attached to the opposite flanges of the bulkhead stiffeners.

BULKHEAD, FORE PEAK--The bulkhead nearest the stem which forms the after boundary of the fore-peak tank. When this bulkhead is extended from the bottom of the ship to the weather deck, it is also called the collision bulkhead.

BULKHEAD, LONGITUDINAL--A partition wall of planking or plating running in a fore-and-aft direction. Oil tankers are required to have at least one fore-and-aft bulkhead in the cargo oil space. Fore-and-aft bulkheads are very common on warships.

BULKHEAD, OILTIGHT--A partition of plating reinforced where necessary with stiffening bars and capable of preventing the flow of oil under pressure from one compartment to another.

BULKHEAD, PARTIAL--A term applied to a bulkhead that extends only a portion of the way across a compartment. Generally erected as strength members of the structure.

BULKHEAD, TRANSVERSE--A partition wall of planking or plating running in an athwartship direction across a portion or the whole breadth of a ship. The principal function of transverse bulkheads is to divide the ship into a series of watertight compartments so that any rupture of the shell will not cause the loss of the vessel.

BULKHEAD, WATERTIGHT--A partition of plating reinforced where necessary with stiffening bars and capable of preventing water from entering.

BULWARK--A term applied to the strake of shell plating or the side planking above a weather deck. It helps to keep the deck dry and also serves as a guard against losing deck cargo or men overboard.

BUTT--The joint formed when two parts are placed end to end.

BUTTOCK--The rounded-in overhanging part on each side of the stern in front of the rudder, merging underneath in the run.

BUTTOCK LINES--Reference lines used in establishing distances athwartship; they are measured from the center line. An intersection of moulded surface with a vertical longitudinal plane.

BUTT STRAP--A term applied to a strip of plate as a connecting strap between the butted ends of plating. The strap connections at the sides are called seam straps.

CALK--The operation of jamming material into the contact area to make a joint watertight or oiltight.

CAMBER, ROUND OF BEAM--The curved shape of the weather decks of ships, rounded up or arched in an athwartship direction for the purpose of draining any water that may fall on them to the sides of the ship where it can be led overboard through scuppers. The camber or round of the beam is expressed in inches in connection with the greatest molded breadth of the ship in feet; thus, "the main deck has a camber of 10" in 40'-0"." It is measured at the center line of the ship at the greatest molded breadth and is the distance from the chord to the top of the arc.

CARGO BOOM--Heavy boom used in loading cargo. See "boom".

CARGO HATCH--Large opening in the deck to permit loading of cargo.

CARGO PORT--An opening in the side of a vessel provided with a watertight cover door, through which the cargo is received and discharged.

CENTER LINE--The middle line of the ship from stem to stern as shown in any water line view.

CHAIN LOCKER--Compartment in forward lower portion of ship in which anchor chain is stowed.

CLIP--A short angle bar welded to floors, plates, webs, etc. It is used as a holdfast, which, with the aid of a bolt, pulls objects up close in fitting, and is also used to attach and connect the various members of the ship's structure.

COAMING, HATCH--A frame bounding a hatch for the purpose of stiffening the edges of the opening and forming the support for the covers.

COFFERDAM--A void or empty space separating two or more compartments for the purpose of insulation, or to prevent the liquid contents of one compartment from entering another in the event of the failure of the walls of one.

COMPANIONWAY--A set of steps or ladder leading from one deck level to another.

COMPARTMENT--A subdivision of space or room in a ship.

COMPOSITE VESSEL--A vessel with a steel frame and wooden shell and decks.

COUNTERSUNK HOLE--A hold tapered or beveled around its edge to allow a rivet or bolt head to seat flush with or below the surface of the bolted objects.

COUNTERSUNK RIVET--A rivet driven flush on one or both sides.

CROW'S NEST--A lookout station attached to or near the head of a mast.

DAVIT--Heavy vertical column of which the upper end is offset by bending the upper section into a curve, used as a crane to support the end of a boat when hoisting or lowering.

DEADLIGHT--A fixed glass in a bulkhead or deck for admitting light and permitting vision. Also a cover for an air port to prevent interior light from being seen from the exterior.

DECK--A deck in a ship corresponds to a floor in a building. It is the plating, planking, or covering of any tier of beams above the inner bottom, forming a floor, either in the hull or superstructure of a ship.

DECK, AFTER--A term applied to a partial superstructure that does not extend from side to side of a vessel; e.g., a bridge, poop, or forecastle deck.

DECK HOUSE--A term applied to a partial superstructure that does not extend from side to side of a vessel like a bridge, poop, or forecastle.

DECK, QUARTER--A term applied to the after portion of a weather deck. In a warship, that portion alloted to the use of the officers.

DECK STRINGER--The strip of deck plating that runs along the outer edge of a deck.

DISPLACEMENT--The amount or quantity of water displaced by a floating vessel. It exactly equals the weight of the vessel itself with whatever is on board at the time at which the displacement is recorded.

DOG--A short metal rod or bar fashioned to form a clamp or clip, used for holding watertight doors, manholes, or pieces of work in place.

DONKEY ENGINE--A small gas, steam or electric auxiliary engine set on the deck and used for lifting, etc.

DOOR, WATERTIGHT--A door so constructed that when closed, it will prevent water under pressure from passing through.

DOUBLE BOTTOM--A term applied to the space between the inner and outer bottom skins of a vessel. Also applied to indicate that a ship has a complete inner or extra envelope of watertight bottom plating. A double bottom is usually fitted in large ships extending from bilge to bilge and nearly the whole length fore-and-aft. In United States Naval practice the following nomenclature has been adopted for bottoms and spaces between same. Where there are two bottoms, the outer is called the "shell", the inner the "inner bottom", and the space between "the bottom tank", or "void" if nothing is carried therein. Where there are three bottoms, the outer is called the "shell", the next above or second level the "lower inner bottom", and the inner or uppermost the "upper inner bottom". The space between the shell and the lower inner bottom is called the "lower bottom tank" or "void", and the space between the lower inner bottom and the upper inner bottom is called the "upper bottom tank".

DOUBLER PLATE--An extra plate secured to the original plating for additional strength or to compensate for an opening in the structure.

DRAFT (DRAUGHT)--The depth of a vessel below the waterline measured vertically to the lowest part of the hull, propellers or other reference points.

FANTAIL--The overhanging stern section of vessels which have round or elliptical after endings to uppermost decks and which extend well abaft the after perpendicular.

FATHOM--A nautical unit of length, six feet.

FIDLEY DECK--A partially raised deck over the engine boiler rooms, usually around smokestack.

FILLET--A term applied to the metal filling in the bosom or concave corners where abrupt changes in direction occur in the surface of a casting, forging, or welded unit.

FIRE CONTROL--Pertaining to the direction, the control, and the firing of the vessel's batteries.

FLAGSTAFF (Ensign Staff)--Flag pole, usually at the stern of a ship; carries the ensign.

FLANGE--The turned edge of a plate or girder which acts to resist bending. The turned edge of a plate, or shape for tying in intersecting structural members. A casting or forging attached to or worked integral with a pipe to form a disc on the exterior of the pipe, for connecting lengths of pipe.

FLAT--A small partial deck, built level, without curvature.

FLUX--A substance, such as borax, used in welding and brazing to help in the process. Flux also serves to stabilize the electric arc, steady the flow of the filler metal into the weld, and protect the weld from oxidation.

FORE--A term used to indicate that part of a ship at or adjacent to the bow. Also applied to that portion and parts of the ship lying between the midship section and stem, as forebody, forehold, and foremast.

FORE-AND-AFT--Parallel to the ship's center line.

FORECASTLE--A short structure at the forward end of a vessel formed by carrying up the ship's shell plating a deck height above the level of her uppermost complete deck, and fitting a deck over the length of this structure.

FORE PEAK--The extreme forward end of the vessel below decks. The forward trimming tank.

FORWARD--In the direction of the Stem.

FRAME--A term generally used to designate one of the transverse ribs that make up the skeleton of a ship. The frames act as stiffeners, holding the outside plating in shape and maintaining the transverse form of the ship.

FRAME SPACING--The fore-and-aft distances between frames, heel to heel.

GALLEY--The space on a vessel in which the food is prepared and cooked.

GALVANIZING--The process of coating one metal with another, ordinarily applied to the coating of iron or steel with zinc. The chief purpose of galvanizing is to prevent corrosion.

GANGBOARD, GANGPLANK--A term applied to boards or a movable platform used in transferring passengers or cargo from a vessel to or from a dock.

GANGWAY--The term applied to a place of exit from a vessel. Gangways are fitted in the sides of a vessel in the shape of ports requiring means of closure, or may be movable portions of bulwarks or railing on the weather decks.

GASKETS--Packing materials, such as rubber, canvas, asbestos, paper, sheet lead and copper, soft iron, etc., by which air, water, oil, or steam tightness is secured at doors, hatches, steam cylinders, manhole covers, in valves, or between the flanges of pipes, etc.

GIRDER--Large single or compound beams that provide support and rigidity to smaller and more closely spaced beams. In the case of long girders, there may be several intermediate supports such as stanchions.

GRATING--A structure of metal bars so arranged as to give a support or footing over an opening, while still providing spaces between the members for the passage of light and the circulation of air.

HATCH--Hatchway cover. Also used to indicate Hatchway.

HATCHWAY--One of the large square openings in the deck of a ship through which freight or machinery is hoisted in or out, and access is had to the hold or machinery spaces.

HELM--A term applied to the tiller, wheel, or steering gear, and also the rudder.

HOLD--Space or compartment between the lowermost deck and the bottom of the ship, or top of the inner bottom if one is fitted. The space below decks allotted for the stowage of cargo.

HULL--The framework of a vessel, together with all decks, deck houses, the inside and outside plating or planking, but exclusive of masts, yards, rigging, and all outfit or equipment.

INBOARD--Toward the center; within the vessel's shell and below the weather decks.

JACKSTAFF--Flagpole at the bow of a ship.

KEEL--A center line strength member running fore-and-aft along the bottom of a ship and often referred to as the backbone.

KING POST--A strong vertical post used to support a derrick boom.

LAP--A joint in which one part overlaps the other, thus avoiding the use of a butt strap.

LIGHT PORT--An opening in a ship's side, provided with a glazed lid or cover.

LIGHTENING HOLE--A hole cut out of any structural member, as in the web, where very little loss of strength will occur. These holes reduce the weight and in many cases serve as access holes.

LINER--A piece of metal used for the purpose of filling up a space between a bar and a plate or between two plates; a filler.

LONGITUDINAL GIRDER--A term applied to the fore-and-aft girders in the bottom of a ship.

MAGAZINE--Spaces or compartments devoted to the stowage of ammunition.

MAIN DECK--The principal deck of the main hull, usually the highest extending from stem to stern and providing strength to the main hull.

MANHOLE--A round or oval hole cut in decks, tanks, boilers, etc., for the purpose of providing access.

MAST--A large, long spar set in an upright position, usually located on a center line.

MESSROOM--A space or compartment where members of the crew eat their meals; a dining room. (A dining room in which officers eat their meals is called a wardroom messroom.)

MIDSHIP--At the middle of the ship's length.

MIDSHIP SECTION--The vertical transverse section located at the midpoint between the forward and after perpendiculars. Usually this is the largest section of the ship in area.

OUTBOARD--Away from the center toward the outside; without the hull.

PEEN--To round off or shape an object, smoothing out burrs and rough edges.

PILLAR--Vertical member or column giving support to a deck.

PLATFORM--A partial deck.

PLATING, SHELL--The plating forming the outside skin of a vessel. In addition to constituting a watertight envelope for the hull, it contributes largely to the strength of the vessel.

POOP DECK--The structure or raised deck at the after end of a vessel.

PORT--The left-hand side of a ship when looking from aft forward. Also an opening.

PUNCH--A machine for punching holes in plates and shapes.

QUARTERS--The living spaces for passengers or personnel. It includes state rooms, dining salons, mess rooms, lounging places, passages connected with the foregoing, etc; individual stations for personnel for fire or boat drill, etc.

RAIL--The upper edge of the bulwarks.

REAMING--Enlarging a hole by means of revolving in it a cylindrical, slightly tapered tool which has cutting edges running along its sides.

RIGGING--A term used collectively for all the ropes and chains employed to support the masts, yards, and booms of a vessel, and to operate the movable parts of same.

RIVET--A metal pin used for connecting two or more pieces of material by inserting it into holes punched or drilled in the pieces. The end that bears a finished shape is called the head and the end upon which some operation is performed after its insertion is called the point. Small rivets are "driven cold"; i.e., without heating, but large ones are heated so that points may be formed by hammering.

SAMSON POST--A heavy vertical post that supports cargo booms. Also King Post.

SCREEN BULKHEAD--A light bulkhead used to shelter from excess of heat, cold or light, or to conceal from sight.

SCUTTLE--A small opening, usually circular in shape and generally fitted in decks to provide access. Often termed escape scuttles.

SHAFT ALLEY--A watertight passage, housing the propeller shafting from the engine room to the bulkhead at which the stern tubes commence. It provides access to the shafting and its bearings, and also prevents any damage to the same from cargo in the space through which it passes. This space is frequently used for wireway runs.

SHEARS--Large machine for cutting plates and shapes.

SHEER--The longitudinal curve of a vessel's rails, decks, etc., from a straight line fore-and-aft. The amount by which the height of the weather deck at the after or forward perpendicular exceeds that at the mid perpendicular.

SHELTER DECK--A term applied to a deck fitted from stem to stern on a relatively light superstructure.

SKIN--The term usually applied to the outside plating of the ship which forms the watertight envelope over the framework. It is also applied to the inner bottom plating, when it is called an inner skin.

SPAN--The distance between any two similar members, as the span of the frames. Also used to describe the length of a member between its supports, as the span of a girder.

SPAR--A term applied to a steel or wood pole serving as a mast, boom, gaff, yard, bowsprit, etc.

STANCHION--A short column or support for decks, hand rails, etc. Stanchions are made of pipe, steel shapes, or rods according to the location and purpose they serve.

STARBOARD--The right-hand side of the ship when looking from aft forward. Opposite to port.

STAYS--The ropes, whether hemp or wire, that support the lower masts, topmasts, top-gallant masts, etc., in a fore-and-aft direction.

STEERING GEAR--A term applied to the steering wheels, leads, steering engine and fittings by which the rudder is turned.

STERN--The after end of a vessel.

STIFFENER--An angle bar, T-bar, channel, etc., used to stiffen plating of a bulkhead, etc.

STOP WATER--Canvas and red lead or other material fitted between two metal parts to make a watertight joint.

STRINGER--A fore-and-aft girder running along the side of a ship; also the outboard strake of plating on any deck.

SUPERSTRUCTURE--A structure built above the uppermost complete deck; a pilot house, bridge, galley house, etc.

TEMPLATE--A mold or pattern made to the exact size of a piece of work that is to be laid out or formed and on which such information as the positions of rivet holes, size of laps, etc., is indicated.

TOP BREADTH LINES--The width of a vessel measured across the shelter deck.

TOPSIDE--That portion of the side of the hull which is above the designed waterline.

TRANSVERSE--At right angles to the ship's fore-and-aft center line.

TRUNK--A vertical or inclined shaft formed by bulkheads or casings extending one or more deck heights, around openings in the decks, through which access can be obtained, cargo stores handled, or ventilation provided without disturbing or interfering with the contents or arrangements of the adjoining spaces.

TURRET--A structure designed for the mounting and handling of the guns and accessories (usually main battery guns) of a war vessel. Turrets are constructed to revolve about a vertical axis by means of electrical or hydraulic machinery.

UPPER DECK--A partial deck above the main deck amidship.

UPTAKE--A sheet metal conduit connecting the boiler smoke box with the base of the smokestack. It conveys the smoke and hot gases from the boiler to the stack and is usually made with double walls, with an air space between, to prevent radiation of heat into adjacent space.

VOICE TUBE--A tube designed for the carriage of the voice from one part of the ship to another. They are generally made up to about four inches in diameter and fitted with appropriate speaking and listening terminals.

WARDROOM--A room or space on shipboard set aside for use of officers.

WATER LINE--A term used to describe a line drawn parallel to the molded base line and at a certain height above it, as the 10 ft. water line. It represents a plane parallel to the surface of water when the vessel is floating on an even keel, i.e. without trim. Used also to describe the line of intersection of the surface of the water with the hull of the ship at any draft and any condition of trim.

WATERTIGHT COMPARTMENT--A space or compartment within a ship having its top, bottom, and sides constructed in such a manner as to prevent the leakage of water into or from the space.

WEATHER DECK--The deck exposed to the elements.

WEB--The vertical portion of a beam; the athwartship portion of a frame.

WEB FRAME--A frame with a deep web.

WELDING--Making a joint of two metal parts by fusing the metals of the parts where they join into one structure.

WINCH--A hoisting or pulling machine fitted with a drum. A winch is used principally to handle, hoist and lower cargo from a dock or lighter to the hold of a ship, and vice versa.

WINDLASS--An apparatus operated by means of a steam engine or motor for the purpose of handling heavy anchor chains, hawsers, etc.

YARD--A term applied to a spar attached at its middle portion to a mast and running athwartship across a vessel as a support for a square sail, single halyards, lights, etc.

YARDARM--A term applied to the outer end of a yard.

ALTERNATING CURRENT (A.C. or a.c.)--An electric current which reverses in direction at rapid regular intervals, usually 120 times per second (60 cycles).

ALTERNATOR--An electric generator which produces alternating current.

AMMETER (Amm.)--An instrument used in measuring current flow in an electric circuit.

AMPERE (Amp.)--The unit of measurement of electric current. One ampere is the current which will flow when a pressure of one volt is applied to a resistance of one ohm.

AMPERE TURNS--The product obtained by multiplying the number of turns in a magnetic coil by the current strength in amperes.

APPARENT POWER--The product of the amperes times volts (VA) in an inductive A.C. circuit as distinguished from the true power which is indicated by a wattmeter.

APPLIANCE--A power consuming equipment, fixed or portable; such as small heating, cooking, and motor operated equipment.

ARC--The flash occurring between the terminals of an electric circuit when the circuit has been interrupted.

ARMATURE (Arm.)--The revolving member of a dynamo.

A.W.G. (American Wire Gauge)--A standard for gauging the size of wires used for electrical purposes.

BALANCED CIRCUIT--A three wire a-c circuit having the same load in amperes in each wire. A three-wire d-c circuit having the same load in amperes in each wire on either side of the neutral wire.

BOSS--Extra molded metal on equipments to permit drilling and tapping entries.

BRANCH CIRCUIT (Br.)--That portion of a wiring system extending beyond the final automatic over-current circuit protective device (such as fuses or circuit breakers).

CABLE--An insulated electrical conductor (single conductor cable) or a group of conductors insulated from one another (multiple-conductor cable) under a common covering.

CARRYING CAPACITY--The safe-load current carrying capacity of a conductor expressed in amperes.

CIRCUIT BREAKER (C.B.)--A device designed to open a current-carrying circuit without injury to itself. The term is usually used to refer to the automatic type designed to trip on a predetermined overload of current.

CIRCUITS, PARALLEL, SERIES, SERIES-PARALLEL

Parallel--A circuit having a common return, between which two or more pieces of power consuming equipments are connected, each receiving a separate portion of the current flow from the common feed.

Series--When two or more pieces of power consuming equipments are so connected that the current feeding one must pass through the others, they are said to be in series.

Series-Parallel--A circuit made up of two or more parallel circuits all joined in series.

CIRCULAR MIL AREA (C.M.)--The diameter of a circle in mils squared, used to express wire size. Example:
1/4" dia. = .250" dia. = 250 mils dia.
Circular mil area = (diameter in mils)^2
$(250)^2$ = 62,500 circular mils.

CLOSED CIRCUIT--A complete path from the source through an external circuit back to the source.

COLOR CODE--A standard of colorings to permit easy tracing of conductors in a cable.

CONDUCTOR (Cond.)--A substance which readily permits the flow of electric current through it.

CONTROLLER (Cont.)--A device sometimes used in multiple, which serves to start, stop and/or govern in some predetermined manner, electric power delivered to the device governed.

CURRENT--The flow of electrical energy along conductor between two points having different potentials.

CURRENT, ACTIVE OR EFFECTIVE--In alternating current that part in phase with the voltage, or the effective value of current contributing to useful power.

DELTA CONNECTION--The connection of the circuits in a three phase system in which the terminal connections are triangular like the Greek letter delta Δ.

DIRECT CURRENT (D.C. or d.c.)--A current flowing constantly in one direction.

DUSTPROOF (D.P.)--So constructed or protected that an accumulation of dust will not interfere with its successful operation.

DUST-TIGHT (D.T.)--So constructed that dust will not enter the enclosing case.

DYNAMO--An electrical machine for converting mechanical energy into electrical energy.

ELECTRODE--Either a positive or negative pole or terminal in an electric circuit. See polarity.

ENCLOSED--Surrounded by a case which will prevent accidental contact of persons or objects with its parts.

EXPLOSION-PROOF (E.P.)--A case enclosure to withstand an explosion of a specified gas or dust which may occur within it, and to prevent the ignition of the gas or dust surrounding the enclosure, by sparks, flashes, or explosion which may occur within the enclosure.

EXPOSED--Accessible; not concealed.

EXTERNALLY OPERABLE--Capable of being operated without exposing the operator to contact with live parts. (This term is applied to equipment such as a switch that is enclosed in a case or cabinet.)

FEEDER CIRCUIT--A circuit that supplies current from a switchboard to a distrition box or another switchboard.

FUSE--An electrical safety device (which is a weak thermal link in the circuit) which melts ("blows out") when the flow of the current is greater than that for which the fuse is rated. This protects the circuit against damaging overloads beyond the designed capacity.

FUSE CLIP--A spring device which holds the ferrules of a cartridge fuse.

GENERATOR (Gen.)--A term applied generally to machines which are used for the transformation of mechanical energy into electrical energy.

GROUNDED CIRCUIT--One which provides an electrical connection between a wire carrying current and the ground. May be deliberate, or may be accidental because of faulty cable insulation, broken parts, or errors in wiring.

GROUND WIRE--A conductor which is used to connect the equipment, device or wiring system with the ground.

HORSEPOWER (H.P.)--Measure of time rate of doing work. It is defined as the equivalent of raising 33,000 lbs. one foot in one minute. One horsepower equals 746 watts.

IMPEDANCE (Z)--The total opposition in an electric circuit to the flow of an alternating current. The square root of the sum of the squares of resistance and reactance.

$$\text{Impedance} = \sqrt{(\text{resistance})^2 + (\text{reactance})^2}$$

KICKPIPE (K.P.)--A short length of pipe used to protect a cable as it rises from a deck or platform.

KILOWATT (K.W.)--Unit of power. It is the equivalent of 1,000 watts or 1.34 horsepower.

LUG--A fitting which may be attached to the end of a conductor to make a connection to a terminal block or terminal stud.

MAIN CIRCUIT--A circuit that supplies current from a distribution box or panel to the final automatic over-current protective device for that circuit.

"MEGGER" (Megohmmeter)--An electrical instrument consisting of an ohmmeter calibrated in megohms (1 million ohms), and a hand operated generator to supply current. Usually used to test resistance of insulation and to find grounded cables.

MEGOHM--A unit of electrical resistance equal to one million ohms.

MIL--A unit of lineal measure. One mil equals .001 inch.

MOTOR--A machine which transfers electrical energy into mechanical energy.

MOTOR-GENERATOR (M/G)--A motor connected directly to a generator for changing or converting from one type of voltage to another.

NIPPLE--A short length of pipe threaded on both ends.

NON-WATERTIGHT (N.W.T.)--Applied to a bulkhead or electrical device that is not watertight.

OHM (Ω)--Unit of resistance to the flow of electric current through a conductor; standardized as the amount of resistance existing in a conductor when 1 volt causes a current of 1 ampere to flow.

OHM'S LAW--A law which states that the current (I) flowing in a circuit is proportional to the voltage (E) and inversely proportional to the resistance (R). Expressed in mathematical form:

$$I = \frac{E}{R}; \quad R = \frac{E}{I}; \quad E = IR$$

OPEN CIRCUIT--A circuit which is not electrically complete and hence has no current flowing.

PAD--A metal cylinder, commonly 5/8" diameter and 3/8" long, drilled and tapped in the center, which is welded to bulkheads, etc. for receiving mounting screws of fixtures, strap hangers, etc.

PANELBOARD--A single panel, (or a group of panel units designed for assembly in the form of a single panel) including buses, and with or without switches and/or automatic protective devices, for the control of light, heat or power circuits.

POLARITY--The property possessed by electrified bodies by which they exert forces in opposite directions. The current in an electrical circuit passes from the positive to the negative pole. In welding, more heat is generated on the positive pole than on the negative one, so that the welding rod is generally made the negative electrode.

PORTABLE APPLIANCE--An appliance capable of being readily removed from its source of current by means of a flexible cord and an attachment plug.

POWER (Pwr.)--The rate of work done by electric current, usually expressed in watts.

POWER FACTOR (P.F.)--The ratio of true power (watts as indicated by a wattmeter) to the volt amperes (volts times amperes as read by the voltmeter and ammeter respectively), in single phase a.c. circuits. P.F. = $\frac{\text{true power (w)}}{\text{volt amperes (VxA)}}$

REACTANCE (X)--In an alternating current circuit, that component of the impedance that does not oppose the flow of current, but tends to cause a difference of phase between it and the electromotive force.

READILY ACCESSIBLE--Capable of being reached easily and quickly, for operation, renewal, or inspection.

RESISTANCE--That property of a substance that opposes the flow of electric current through it. See Ohm.

RHEOSTAT--A device which regulates electrical current, by conducting the current through wires having considerable resistance (which may be varied).

ROTOR--The rotating member of an a.c. motor or generator.

SHORT CIRCUIT--A path of low resistance placed across an electrical circuit causing an abnormal flow of current.

STAR CONNECTION (Also known as Y connection)--Three-phase generators and transformers have three coils which may be connected star, Y or delta. When one terminal of each coil is connected together and the other three terminals are brought out separately, the connection is called star or Y.

STATOR--The fixed part in an a.c. motor or generator.

STRANDED WIRE--Wires or cables made up of a number of small wires braided or twisted together, but with fewer strands than flexible wire.

SWITCHBOARD (Swbd.)--A large single panel, frame, or assembly of panels on which are mounted, on the face or back or both, switches, over-current, and other protective devices, fuses, and usually instruments. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets.

TRANSFORMER--A device used to raise or lower the voltage of an alternating circuit. It consists of an induction coil having primary and secondary windings wound on a closed iron core.

VOLT (E or V)--Unit of electromotive force electrical pressure.

VOLTAGE--The greatest effective difference of potential between any two conductors of a circuit. The electromotive force in a circuit.

VOLTMETER (V.M.)--An instrument for measuring voltage.

WATERPROOF (W.P.)--So constructed or protected that moisture will not interfere with its successful operation.

WATERTIGHT EQUIPMENT (W.T.)--So constructed that moisture will not enter the enclosing case.

WATT (W.)--Unit of true power.
D.C. watts = Volts x Amperes. W = EI
A.C. watts = W = $(EI)_{pf}$*
*Power factor

WATT-HOUR METER (W.H.M.)--An instrument for measuring electric power in watts.

WEATHERPROOF--So constructed or protected that exposure to the weather will not interfere with its successful operation.